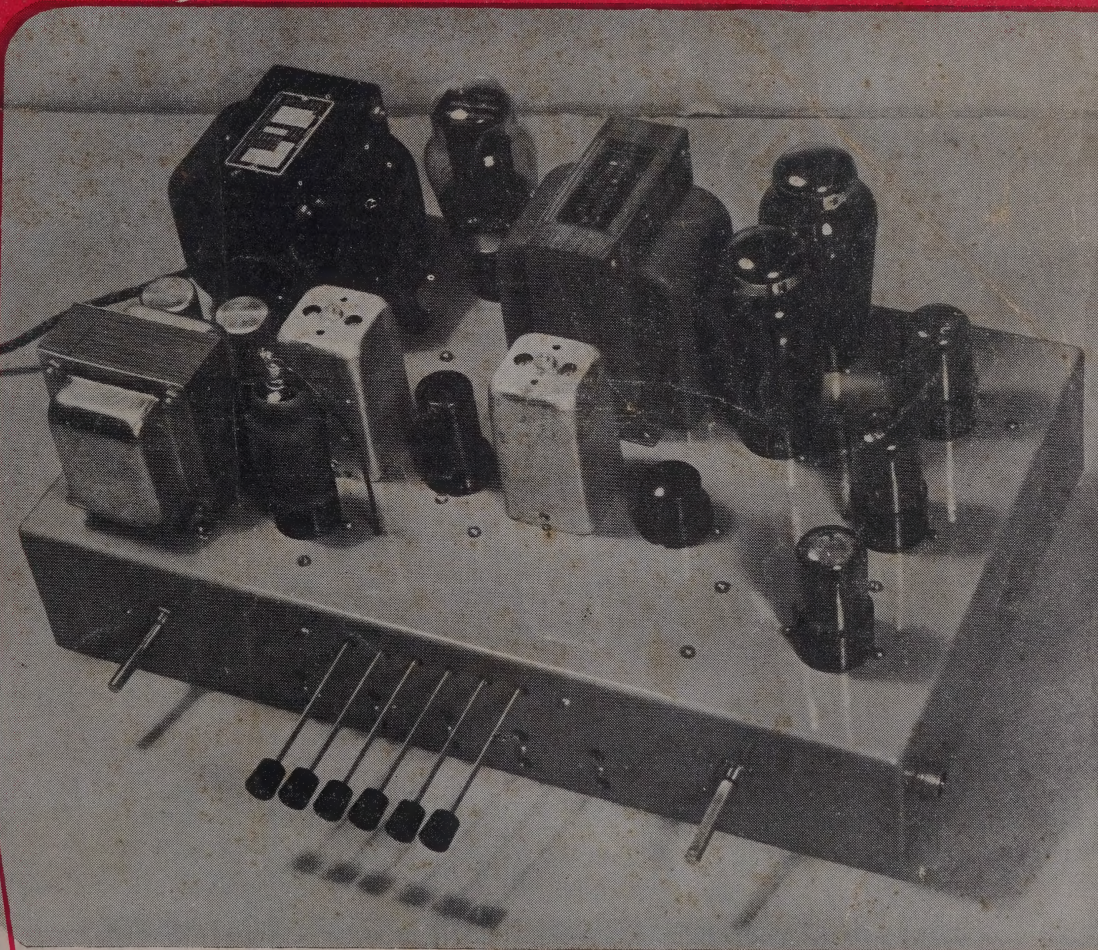
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



In this Issue: THE *RADIO AND ELECTRONICS* AMPLI-TUNER
RADIO CONTROL OF MODELS

SEPTEMBER 1, 1949 VOL 4 NO. 7 1/10

RADIO and ELECTRONICS

Vol. 4, No. 7 September, 1 1949

OUR COVER

The cover picture this month shows a general view of the high-quality amplifier, with built-in wide-band broadcast tuner, that is described in this issue. The push-buttons are used both for tuning and for the radio/gram switching.

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A NEW ZEALAND "RIDER'S" MANUAL

Since we have become self-supporting in the manufacture of domestic radio sets, through the efforts of a very live and up-to-date radio-manufacturing industry, there is a very real need for better dissemination of service information to radio servicemen throughout the country. We do not mean by this that the manufacturers do not look after their own retail agents in this respect. Many service businesses do not make initial sales of any particular make of set, and those which are also retailers for one or more manufacturers are called upon to service not only those sets which they sell themselves, but sets of all conceivable makes. It is for this reason that Rider, in America, has been turning out for many years annual volumes containing service information on the current models of as many manufacturers as possible. These volumes have reached vast proportions, as might be expected, and, although their price is comparatively high, they are so valuable to the vast army of radio servicemen in the United States of America and in other countries where American-made sets are sold that they are eagerly sought after and the price willingly paid.

Our suggestion is that a similar volume, giving details of New Zealand-built sets would be of immense value to our own servicemen, and we doubt whether anyone would seriously contest this statement.

On the assumption that it is correct, we have explored the possibility of turning out just such an annual volume. Unfortunately, printing costs are such that it would be possible to sell the book at a figure which we consider would make it an economic proposition, both from the serviceman's point of view and also from our own, as the prospective publishers. There would undoubtedly be some who would be sufficiently convinced of its value to pay almost any price, were a New Zealand service manual in existence, but there would also be many who would be rather dismayed at a price of several guineas, which would be the unfortunate necessity were we to print a book like that as a commercial venture. We have, in fact, often been asked whether we have at any time considered issuing a manual; the above paragraphs provide the answer.

However, unwilling to be beaten, we have cast about for a means whereby the cost can be minimized, and think we might have hit on a solution. It is that of issuing a loose-leaf binder at a reasonable cost in the first instance, together with reprints of all commercial circuits which have already been published in *Radio and Electronics,* and at the same time to charge an annual fee which will cover the printing and sending out to subscribers of a specified number of service sheets every month. By this means, some of the costs associated with the production of a book would be avoided altogether, and these savings would be passed on to the purchasers.

At present it is not possible to say just what the subscription would be or how many sets per month could be distributed for that fee. Our object in writing about it at this stage is to try and enlist the help of those who are most concerned—namely, the radio servicemen. If it were possible to collect a good and sufficient subscription list in advance of the publication of the loose-leaf binder and the initial batch of service sheets, it would certainly be possible to put the scheme into operation. What we are asking servicemen to do is this: Write to *Radio and Electronics* (N.Z.), Ltd., intimating whether the writer would be interested in subscribing to such a scheme and how much he thinks a production of, say, 200 sheets within a period of 12 months would be worth to him.

It is only by obtaining as many opinions as possible on the value of a New Zealand "Rider's" that we can begin to estimate whether the job can be done at all. We can say at the outset that if sufficient support is forthcoming, the scheme will be put into operation, and, further, that if an adequate response does not arise, only one assumption can be made: a service manual is not needed in New Zealand.


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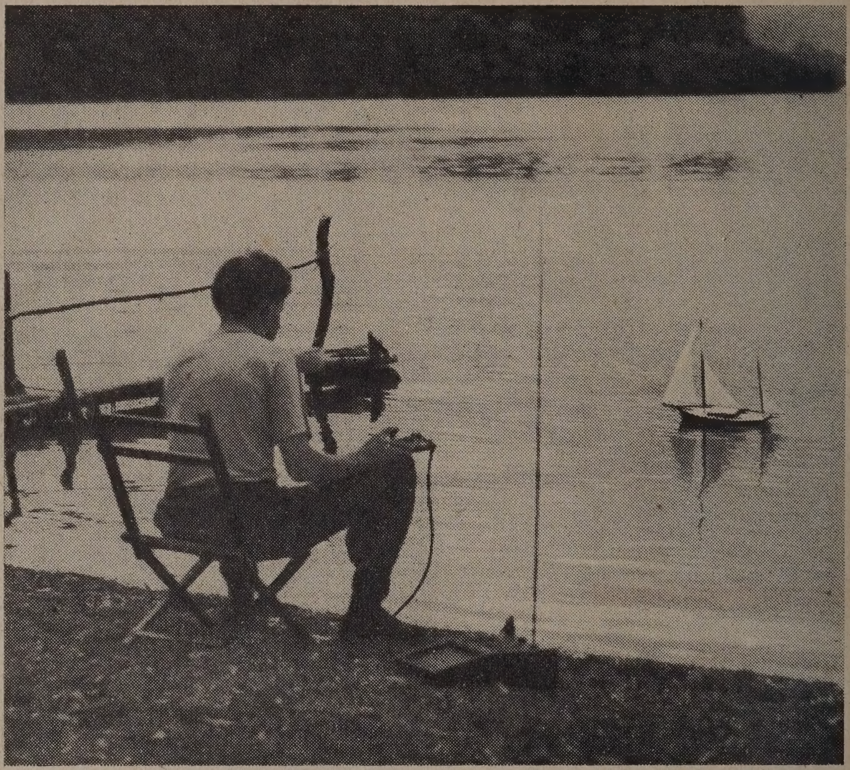
RADIO CONTROL OF MODELS

By L. H. WRIGHT

Mr. Wright is an acknowledged expert in this comparatively new field of radio endeavour, and we are very lucky to have secured this series of articles from him. The subject is one on which there is still much room for experiment, and Mr. Wright hopes that many enthusiasts will be impelled, after reading his articles to try something of the kind for themselves.

Your Editor has asked me to write a short article on radio control as applied to models, and I can't do better than to amplify a few notes of a lecture I delivered recently to the Wellington branch of the N.Z.A.R.T. An outline of the history and a survey of past efforts will help to clear the air and give the reader a broader view of the subject.



A model yacht being controlled by a small battery-operated oscillator.

Remote control by means of radio transmission is almost as old as radio itself. In its extreme infancy there were many who thought that the principal use of radio would be for control purposes. Old hands who remember the coherer detector will realize that it was nothing more than a relay—the electrical sense. It is therefore all the more surprising that the problem of remote control of models has only recently been successfully solved. By "successfully" I mean that the ability of the average radio amateur is sufficient to enable him to assemble and get the equipment to work. As far back as 1916 a small model boat was steered by radio, and since that time some very ingenious methods have been suggested, most—if not all—being thoroughly impracticable.

And then—about 12 years ago when small petrol driven model aeroplanes became popular, their suitability for radio control became apparent and dozens of amateurs turned their thoughts in this direction. But the problem was really tough and little or no success was had until Mr. Ross A. Hull, at that time associate editor of the transmitters' periodical *Q.S.T.*, made his memorable appeal to the amateur transmitters of America to concentrate on the job. He set the ball rolling by constructing a successful 10 ft. wingspan radio controlled sailplane. This was in 1937 and since then many hundreds of models have been controlled in America and England to show that radio control is thoroughly practical.

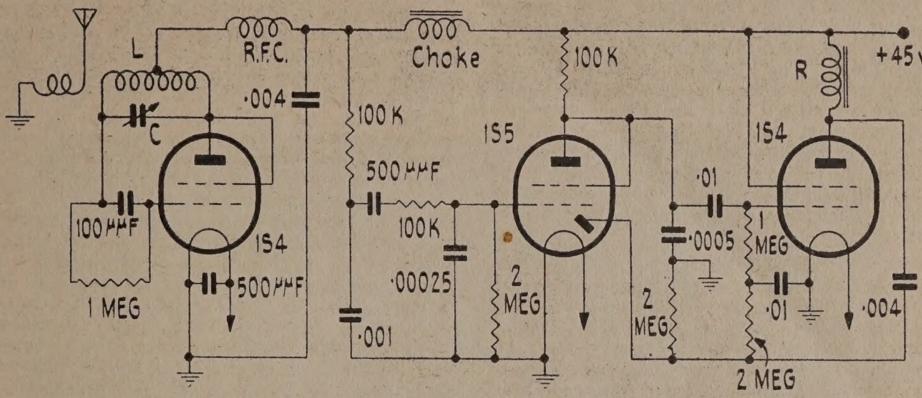
As a consequence of the last war England has been severely handicapped. All permits for operating transmitters were cancelled in 1939 and actual petrol model aeroplane flying was prohibited shortly afterwards.

In America, however, no such restrictions were placed on model flying and until America entered the war, national model aeroplane contests were held at which competitions were arranged for controlled models, and literally dozens of very keen amateurs concentrated on the job. It was from these ranks of enthusiastic amateurs that the U.S. Army and Navy drew a team to develop and operate their controlled planes used for target practice. It is therefore to America that we must look for the latest and most interesting developments.

Before getting down to the description of a practical unit, let us briefly outline some of the various methods used in the past. Let it here be explained that sufficient transmitted energy to do any actual work on the model is impossible and that all action is initiated by a sensitive relay which alone is controlled by the radio; so that at this stage we are only interested in the opening and closing of a relay. What comes after the relay is another story. Discounting the coherer and all pre-1936 efforts, one of the most popular methods was the reception, and rectification of a modu-

lated signal to change the current of a relay valve. Another was to produce a heterodyne note in the receiver, the relay being controlled by a signal on/signal off condition. Modifications of this general theme held the field until Ross A. Hull showed real originality by making use of the characteristic hiss of a super-regenerative detector and its disappearance on the reception of a C.W. signal. The transmitter frequency he chose was 60 mc. The advantages were obvious.

current charge of between ½ and 1 ma., whereas the one described will produce a current charge of up to 8 ma., and so a relatively insensitive and robust relay can be used. The arrangement is suitable for use in any working model and by suitable choice of components, etc., its overall weight can be reduced to less than 16 ozs. Its sensitivity is such that a small power transmitter using battery type valves and a H.T. of 90 volts will give full control within visual range.



Practical circuit for a radio control receiver. This is Mr. Wright's design, and from our own interest in the subject, we have had it working in the "Radio and Electronics" laboratory. There is no doubt of its effectiveness, and, better still, we can vouch for the fact that it holds no difficulties that are beyond the amateur constructor to solve.

Previously all work had been done on the 80-metre band and the aerial in both transmitter and receiver was a problem. To work on the ultra high frequencies meant higher efficiency with lower power.

Three valves were used, one as a super-regenerative detector, one as an amplifier to amplify the characteristic hiss and apply this "hiss" voltage to the grid of the third or relay valve. The heavy "hiss" voltage, being rectified on the grid of the relay valve produced a negative potential to limit the plate current. A relay in the plate circuit was under these circumstances in the open position. Now, on the reception of a C.W. signal the hiss disappeared and the plate current of the relay valve was raised to close the relay contacts. Thus, control was obtained by merely switching on and off the transmitter.

Although small modifications have been subsequently made, this form of control still holds the popular vote.

Finally, shortly before the war a well-known valve manufacturer developed a gas relay valve for the express purpose of radio control. This was the type No. RK62.

This battery-operated triode contains a small quantity of gas which under certain circumstances ionizes to conduct a relatively large relay current. On the reception of a C.W. signal the conditions vary to prevent the gas from ionizing with a consequent reduction of plate current. The action of this valve is the reverse of the previous in that the plate current is reduced with a signal. This valve was also designed to operate on about 60 mc/sec.

And now, after all this preamble, let us get down to something practical. The circuit to be described follows in general principle that suggested by Ross A. Hull. The main difference between the two is merely one of degree in that the original circuit produced a

Reference to the diagram shows a 1S4 valve super-regenerative detector followed by a triode-connected 1S5 and followed again by another 1S4 relay valve. The action is as follows: The characteristic "hiss" of the detector is fed to the grid of the 1S5. After being amplified by this valve it is applied to the grid of the 1S4 relay valve where it is further amplified appearing as a high A.C. voltage of varying frequency across the impedance of the relay. Being a D.C. operated device, the relay is not affected at this stage. However, this "hiss" voltage is passed by a condenser on to the diode section of the 1S5 valve and rectified. The negative D.C. potential produced is filtered and applied to the grid of the relay valve. Now in practice the negative potential produced is sufficient to bias the 1S4 to a point where the plate current is reduced to about .5 ma., the relay being in the open position. On the reception of a C.W. signal the hiss and associated hiss voltage disappears, the bias limiting the plate current of V3 collapses, the relay current rising to 8 or 9 ma. and the relay closes with a snap!

Doesn't everything sound beautifully simple? But there is a little nigger in the woodpile. Let us look at a super-regenerative detector a bit more closely and study its peculiarities. It will be seen that the circuit is nothing more or less than a Hartley oscillator with a very high grid leak. In order to understand its action let us imagine its condition when first switched on. The high battery surge sets off a train of oscillations which, owing to the high resistance in the grid circuit makes the grid increasingly negative until a point is reached at which the plate current is cut off and oscillation ceases. The negative grid charge leaks away until a condition is reached which again favours oscillation. In this case it is some random effect such as thermal agitation, etc., which starts the train of oscillation again and the cycle is repeated. This repetition frequency, governed by the value of grid leak and

condenser is of the order of 25 k.c. it is the irregularity of the starting of each train of oscillation that produces the characteristic hiss and the elimination of the hiss on the reception of a C.W. signal is explained by the fact that each train of oscillation is initiated by the small voltages produced by the transmitter on the current frequency.

But this starting and stopping of oscillating condition produces a very high A.C. voltage on the plate of the detector. It is known as the squegg voltage and is in no way controlled by the transmitter. This squegg must be removed and reference to the diagram will show the elaborate network necessary to eliminate all trace from the diode. The coupling between V1 and V2 is virtually a selective filter arrangement, the higher frequencies being attenuated and the lower hiss frequencies being passed on and amplified by V2 and V3.

As a practical aid in the elimination of the squegg voltages a CRO is of great assistance. The broad envelope of the squegg voltage is readily recognized and any trace on the plate of the relay valve or the diode is at once apparent.

THE RELAY

The D.C. resistance of the relay must *not* exceed 2000 ohms. This is important as the use of a relay of higher resistance may set up a peculiar locking action in which control is completely lost.

This is explained by the fact that the relay valve is also used as an amplifying valve and any conditions which render it incapable of acting as an amplifier will prevent it working as a controlled relay valve. This is obvious.

During the signal on condition, very high current is flowing through the relay and if this has a high resistance, say 3000 ohms, it may drop the plate voltage so far below the screen as to make the valve inoperative and in this case the signal off condition will have no restoring effect.

As mentioned earlier this circuit does not need a very sensitive relay and in many cases a standard P. and T. type relay with a resistance of 500 ohms can be modified slightly to give good results.

Just a few words to describe my own experiences with radio control. The first successful model plane had a wingspan of 8 ft. and weighed 6¾ lb. all up. It was powered by a 1-3 h.p. petrol motor and with this sounding like a miniature motor-cycle the plane would taxi for a few yards to take off in a climbing left turn. Rudder movement only was used which gave perfect control and when the model was "tanked" well up it could be made to climb aloft until it was a tiny speck in the blue, its path faintly visible by a thin white trail of vapour. To perform most of the known and many unknown manoeuvres and then land directly in front of one is very satisfying. Then again, to be able to launch a sailplane with a wingspan of 6 ft. off the top of a ridge and by making use of the currents of air keep it aloft and soaring like a seagull commands quite a portion of skill only acquired through practice. A model speedboat powered by a miniature diesel motor is very spectacular and amusing when zoomed around a group of bathers who do not comprehend what is going on, but for sheer beauty a controlled model yacht is well worth the effort of contstructing. I have mentioned these merely to indicate that it has been done and to try to arouse the necessary interest to get radio control on the map in New Zealand.

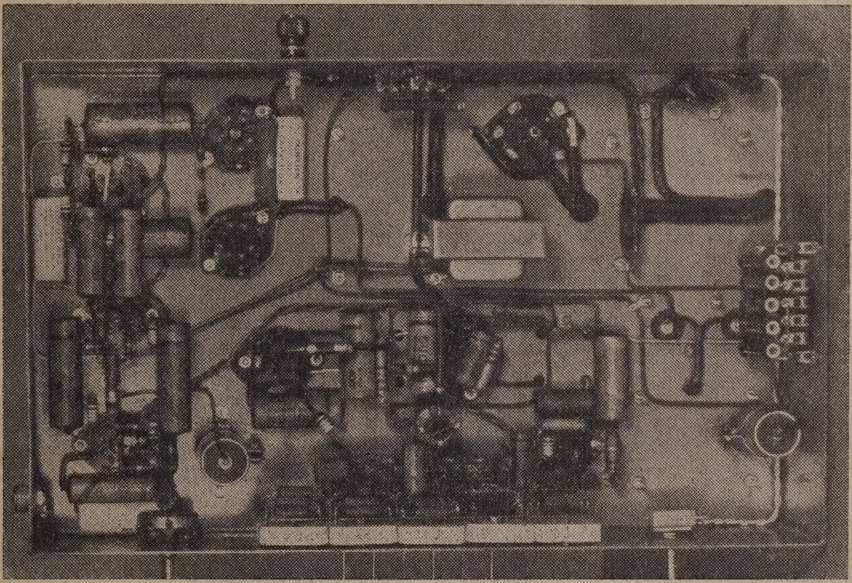
The subject is full of juicy morsels for the experimentally inclined. The radio section is, however, only half the story, and at a later date I hope to be able to beg sufficient space to deal with a few of the mechanical problems associated with the other half.

The "Radio and Electronics" "Ampli-tuner"

An unusual combination for gramophone playing and high-quality broadcast reception —all on the one chassis.

INTRODUCTION

Some little time ago, now, when we published the circuit of our latest high-quality amplifier, to be precise, we forecast the present arrangement, which is designed to contain on one chassis all that is necessary for high-quality gramophone reproduction and also for local broadcast reception with equally high quality.



It has been called the "ampli-tuner," for, although it contains all the essentials of a radio receiver—and, in fact, is one—this name emphasizes the fact that it is primarily a high-quality amplifier, to which a similar tuner has been added as an integral part of its construction. The object is to give the builder a complete outfit that will supply the bulk of his listening requirements. If, for good measure, he wishes to add an ordinary tuner which will give him shortwave and distant broadcast reception as well, then this can be added as a separate chassis. The incorporation of the tuner, in push-button form, on the main amplifier chassis makes it unnecessary to have three or more chassis for the complete outfit, and simplifies the fitting of the main equipment into a fine cabinet.

For example, if one indulges in some large and expensive cabinet-work to house the gramophone turntable and the ampli-tuner, a very neat arrangement would be to place the main chassis vertically, so that the push-buttons and volume control appear inside the lid, as in a good many conventional radio-grams. Then the front of the cabinet need not be spoiled in appearance by the presence of the operating controls, or of the dial, which is usually the main cause of the whole not looking as handsome a piece of furniture as it might otherwise do.

CIRCUITS

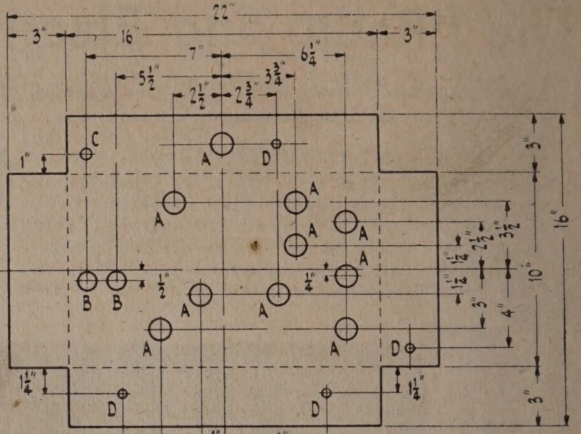
The circuits of the amplifier and tuner that make up the "ampli-tuner" have already been presented in these pages, the amplifier in the June, 1949, issue of this journal, under the title of "A New High-quality Audio Amplifier," and the tuner in the August, 1949, issue, under the heading, "A Push-button Tuner for High-quality Reception." These two units, together with their common power supply, are built together on the one chassis to form the "ampli-tuner." The power supply circuit is given here because it is a little unusual, and shows how we overcame the difficulty of providing only 250 volts for the tuner H.T. from the main H.T. of approximately 370 volts. In order to give a well-smoothed supply for the tuner, an extra stage of filtering has been used after the main single-section filter for the amplifier. This is quite good enough for the latter, because, except for the first valve in the amplifier circuit, all stages are push-pull. Because of this, the filtering does not need to be quite so heavy as in most amplifiers, and it was found that with only a single section the hum-level was well down to high-fidelity requirements. Extra resistance capacity filtering is provided in the amplifier circuit itself for the first 6SN7, which is the first voltage amplifier and phase-inverter in the one envelope.

One fact that is often overlooked is that the tuner of a high-fidelity system must have a very smooth H.T. supply if there is to be no trouble from modulation hum. For this reason, the second filter stage was used; this stage has the advantage that it has to pass only enough current to supply the tuner and the voltage divider. The choke can thus be a small

and inexpensive one, making the whole power supply much cheaper than if a "brute-force" two-section filter had been used for the whole amplifier.

PERFORMANCE FIGURES

When this outfit was completed in our laboratory, the results were so outstanding, as judged by ordinary amplifier standards, that we decided to have a complete set of distortion figures taken. Now, it often happens that when one has some figures taken on an arrangement that sounds very well to the ear, some rude shocks are in store for the unfortunate builder, but in this case (as with all "Radio and Electronics" amplifiers), the amplifier had been thoroughly tested on the oscilloscope, short of actually measuring the percentage distortion at various power outputs and frequencies. We have often stated that an oscilloscope, used in the right way, can tell the observer whether or not the distortion in an amplifier is less than 1 per cent., and our statement in the original amplifier article that the total distortion was less than 1 per cent. at full output was found to be more than substantiated. The method of test was as follows. A general radio distortion factor meter was set up and fed from the output of the amplifier, at 15 ohms, the impedance of the speaker that is being used with it. At the same time, a 'scope was set up to examine the waveform of the output. At each frequency tested, the input was arranged so as to give the greatest output that the 'scope showed as undistorted. At this level, whatever the power output turned out to be, the distortion was then measured on the distortion factor meter.



Now, it will be noted in the table of results below, that at medium and low frequencies, the power output at which measurements were taken was 10

(Continued on page 41.)

A SIMPLE VOLUME-INDICATOR CIRCUIT

Although seldom seen outside broadcast studios, volume indicators can be very usefully applied in a variety of situations. An effective circuit is given which can be attached to any audio amplifier, and which is quite inexpensive. It uses easily-obtained parts throughout.

INTRODUCTION

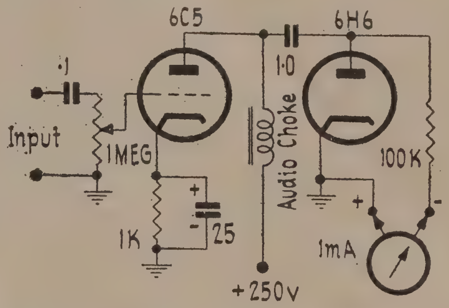
Among the many additions to ordinary equipment that are to be found in broadcast studios, and in other places concerned with transmitting, is the volume indicator, or level indicator. This device tends to be looked upon either as an unnecessary frill or an expensive luxury, but there are many places in audio equipment where it is rather a necessity from time to time if the gear is to be operated properly and consistently.

Perhaps the most outstanding example is the control of volume level in phone transmitters. Here, it is well known that, in order to attain the best possible results, the modulation level should be kept as close to 100 per cent. as possible, especially where the object is communication under difficulties of interference, man-made or otherwise. Because of this, many operators, especially those in charge of amateur stations, turn the gain control up until the phone monitor only just fails to indicate audible distortion. Unfortunately, at this point, over-modulation is frequently occurring, with the result that, although the station monitor sounds quite well, spurious sidebands, commonly known as splatter, are being radiated. Very often, these sidebands are quite some way removed from the carrier, and cause heavy interference to signals that are quite some distance, in terms of frequency, from one's own carrier. This sort of thing is of considerable nuisance value to others working in the band, and there are probably very few amateurs who have not suffered at one time or another from someone else's offences in this direction. However, there are worse possibilities even than this, for over-modulation can even cause interference right outside the band that the transmitter is working in, and this is an offence against the regulations. Even if the carrier is within the band, one is offending against the regulations if any signals whatever are being emitted on frequencies outside it.

It cannot be pretended that a level indicator on the station's audio equipment will prevent over-modulation, but it can go a long way to doing so if it is intelligently used; it would not be outside the bounds of reason if the authorities were to insist that continuous monitoring of modulation percentage be made mandatory should many amateurs working near the edges of the bands draw attention to themselves by consistent over-modulation. However, the advantages of knowing how nearly we are approaching 100 per cent. with our modulation are great enough to provide good reason for fitting a level indicator, apart from anything else. Some amateurs guard against splatter by fitting negative peak clippers and/or volume compressers to their modulating systems, but even here a level indicator can pay dividends by showing whether or not these precautions are actually working.

NOT ONLY FOR TRANSMITTERS

Practically all applications of medium and high-powered audio amplifiers could benefit from the addition of a level indicator. For instance, the public address operator is (or should be) very interested in whether or not his high-powered public address amplifier is being overloaded. His business depends on the quality of his audio output to a perhaps greater extent than he thinks, but, apart from this, a level indicator can save him a tremendous amount of running about and time generally by telling him whether or not he is overloading his amplifier, even if he is so far from the speakers that it is difficult to judge by ear if this is happening. Under working conditions, as when open-air public speeches are being put over his system and the speaker is given to wandering away from the microphone, the level indicator enables the operator to see that the level at the speakers is as constant as possible, thereby



giving considerable help to the listeners and doing a better job for those who have commissioned the work. Gain control settings can easily be forgotten, and the same amplifier is often used with different numbers of speakers on different occasions. The level indicator is of great assistance in enabling the operator to work at speaker volume levels that have been found, by experience, to suit a number of known and standardized arrangements of speakers used with a particular amplifier. Many other good points can no doubt be thought out by the user for himself, as well as the more obvious ones that we have detailed.

HOW DOES THE INDICATOR WORK?

The circuit we are to describe is a very simple one indeed, and contains very few parts to go wrong—always a good feature of what is virtually a small piece of built-in test gear. The triode, which we have drawn as a 6C5 but which can be any suitable medium or low-mu triode, is used as an isolating stage and as a small Class A power amplifier. It will be noticed that it is choke-capacity coupled to the rest of the circuit. There is therefore very little voltage drop in the coupling choke, and almost the full H.T. voltage of 250 is applied to the plate. Under these conditions, the 6C5 is capable of almost a quarter of a watt of power output, which is much more than enough to operate a sensitive moving-coil meter. The output of the triode is coupled, via the 1 μf. condenser to a 6H6, with sections in parallel, used as a rectifier. This has a 100k. load resistor, in series with which is the indicating meter. This can be a 0-1 ma. movement, but one of the inexpensive

war-surplus 0-500 μa. meters that are still available from many retailers will do admirably. Because of the rather small diode load resistor, which gives the diode circuit an input impedance of approximately half the load resistor, or 50k., it is necessary to use a large coupling condenser of at least 1 μf, if the response of the indicator is not to fall off too much at low frequencies. The choke does not need to be an expensive component especially designed for audio frequency work. It can well be the primary winding of an inexpensive output transformer, or a small 50 ma. (or smaller) smoothing choke. If the inductance is not great enough, all that will happen will be a slight falling-off in the response of the indicator at frequencies below 200 c/sec. or so. For the purposes indicated above, this will seldom be much of a disadvantage, because systems that are designed mainly for speech, such as modulators and public address systems, should themselves have the low-frequency range rather severely restricted for best results.

It will also be noted that an input potentiometer has been included in the circuit. The purpose of this is to act as a sensitivity control, so that the meter reading may be set to some convenient value in relation to the maximum power output that is wanted from the modulator or amplifier. This will be discussed further under the heading of using the indicator once it has been installed. However, there is no need for the volume control shaft to be brought out to the front panel. In fact, for most purposes it is better left inside the equipment as a pre-set control, in order to prevent unauthorized re-adjustment, and consequent maladjustment.

APPLYING THE INDICATOR

If there is room on the chassis of the audio equipment whose output the indicator is intended to monitor, the two valves are best mounted there. This enables a short lead to be run from the point on the amplifier from which the circuit is to be worked to the input potentiometer. Doing this does not mean that the actual indicating meter need be placed on the same chassis. On the contrary, there is no reason why a twisted pair of wires cannot be run from the meter terminals as far as we like to the meter itself. This can be placed anywhere that is most convenient, and this will generally be at the operating position, which is often some distance from the audio rack, especially in the case of transmitters. If the voltage amplifying equipment is at the operating position, the whole indicator circuit can be put there. There will be no necessity to shield the wiring if there is a long run from the circuit to the meter, because the meter impedance is so low that no hum that may be picked up can possibly affect its operation. If the chassis of the audio equipment is too full to accommodate the two extra valves, the circuit can be built on a very small sub-chassis, and perhaps mounted on the inside of the case or rack, with space for the meter found on the case or front panel.

Once the circuit has been wired in, it will be necessary to set the 1 meg. input potentiometer so that a particular reading on the meter means something to us when the gear is working.

For instance, if it has been installed on a modulator, we will want to set the sensitivity so that some predetermined meter reading means 100 per cent. modulation of the transmitter. If this is not done, the meter is nothing but a useless ornament. Thus, in order to calibrate the meter, we must know, by some other means, when 100 per cent. modulation has been reached. This can be done by the usual oscilloscope method, which is the best, or by using a carrier-shift indicator to show when over-modulation occurs. To set the meter, a steady tone will be needed, and this is best obtained from an audio oscillator. This should, if possible, have a good sinusoidal waveform, if the oscilloscope method is not used; but, if it is, the waveform of the signal does not matter so much. For a start, we will assume that such a source is available. A simple audio oscillator can be "lashed up" in a very short time, if necessary, or a gramophone pick-up and a constant-frequency record can be used instead. When the signal is passing through the system, the level indicator volume control is advanced a little to ensure that it is working, and is then turned right down.

The main gain control (the one that is normally used to control the output of the modulator) is then

(Continued on page 34.)

WILLIAM JAMES BLACKWELL
"SWAN'S" NEW CHIEF

Bill Blackwell, recently appointed managing director of Swan Electric Co., Ltd., has an unusual combination of technical knowledge and administrative experience. Essentially a technical man in his earlier years, he has always kept up this side of his interest even when, more recently, he has been mainly concerned with organizing and running a big manufacturing plant.

Although he has spent most of his life in New Zealand, Bill was born in England, and received his basic education at Earls Barton School and later at Wellingborough Technical School in Northamptonshire. Like many men of his age, he was attracted to radio and electronics in the early twenties, when broadcasting was starting to find its voice and a whole new world was opening up. The Blackwell family came to New Zealand when Bill was 19, and shortly afterwards he went across to Sydney to study at the Marconi Schools there. He obtained the Commonwealth of Australia first-class P.M.G. Certificate and joined the marine service of A.W.A., starting as ship's radio officer and later carrying out ship installation work.

Electricity and the things that use it have been Bill's interests ever since. He came back to New Zealand in 1930 and switched from marine radio to the domestic radio field, opening up the first A.W.A. Radiola agency in Westport for Frank Higgins, Ltd. For the next few years he looked at radio from the point of view of the small retailer and learned, by hard experience, the sales side of the industry. At the same time he kept up his interest in the technical side, and in 1934 was admitted to the then Institute of Wireless Technology as Associate. In 1943 he was transferred to full membership of the British Institution of Radio Engineers.

His long association with Charles Begg & Co., Ltd., started early in 1936, when he joined the Christchurch branch as radio and electrical service manager. After organizing the service department, he soon transferred to the position of radio and electrical sales manager.

When, in 1939, import control put an end to the importation of complete Philco radio receivers, which Beggs were distributing, Bill was given the task of planning for the manufacture of Philco in New Zealand. He became general manager and director of Dominion Radio and Electrical Corporation, Ltd. (DRECO), manufacturing subsidiary of Beggs, and with full responsibility for design, production, and administration produced the first New Zealand-built Philco radios. That has been his job for the last ten years, and in that time he has steadily expanded production volume, shifting

DRECO out to its modern factory in Newmarket and transforming it from a 12-employee organization to a company with more than 100 on its payroll. Other lines have been added to the DRECO range, including since 1941 the manufacture of the Morphy-Richards automatic iron and more recently the assembly of vacuum cleaners.

As with other manufacturing plants, the war switched DRECO on to work of national importance. Under the direction of the Controller of Radio Production of the Ministry of Supply, Bill reorganized DRECO and expanded its facilities to play a part in the radio industry's war programme, controlling its production on behalf of the Ministry of Supply throughout the war.

Bill was able to add further to his wide experience when, immediately the war finished, he went overseas for 12 months to study manufacturing techniques. Two and a half months in England, six months in the U.S.A. and Canada, including three months in the Philco factories at Philadelphia taught him a great deal of the progress being made in other countries, and on his return he completely reorganized and relaid out DRECO, improving factory methods and increasing production volume.

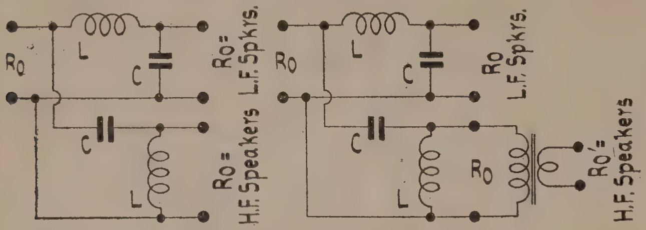
This job of building up from scratch a highly efficient organization has been a big one, but Bill has found time for other activities. A strong believer in the value of and the necessity for the trade organization, he has been president of the Auckland Provincial Radio Traders' Association and national president of the New Zealand Radio Traders' Federation. He has been closely associated with the Radio Manufacturers' Trade Group of the Auckland associa-

(Concluded on page 48.)

QUESTIONS AND ANSWERS

SPEAKER DIVIDING NETWORKS

"G.H.," Wanganui, writes with a query about our last month's article on speaker dividing networks, the circuit of which we reproduce here. He says: "Is there not an error when you say that two 15-ohm speakers are connected to the network and the input terminals of the latter are connected to the 15-ohm winding of the output transformer? Are not two 15 ohms in parallel equal to 7.5 ohms?"



We rather expected someone to bring this point up, but not quite so soon after the publication of the article in question! On the face of it, it does look rather peculiar, but the fact is that the speakers are not in parallel, owing to the interposition of the network, also the network is designed in such a manner that the impedance relationships are correctly shown in the circuit diagram, and there is no question of halving the impedance level at the input of the network.

G.H. also asks whether there is any technical reason against using a special output transformer with separate windings for the two speakers. The answer to this is that the fewer the secondary windings on an output transformer the better the results that can be expected. For instance, high-fidelity transformers are never made with a number of secondary windings, or as a multi-match transformer, because if this is done it is not possible to achieve the same excellent characteristics that can be got when there is only one secondary winding. Otherwise there is nothing against the schemes.

THE "RADIO AND ELECTRONICS" VALVE TESTER

"W.J.W.," Woodville, writes with an alternative scheme for arranging for either directly or indirectly heated valves to be tested by the mutual-conductance tester described in "Radio and Electronics" of October 1948.

The suggested method consists of using a tapped transformer and putting a double-pole double-throw switch in the leads from the outer ends of R5 and R6. As far as we can see, there is no objection at all to this arrangement, which enables any available filament voltage from the transformer to be centre-tapped and the tap taken as the cathode terminal for directly heated valves. W.J.W. also asks whether a 1.4 volt winding could not also be included on the transformer, for testing battery valves, instead of using a separate dry cell as in our circuit, and our reply is that this is perfectly practicable. In addition, the tester, as shown, is not suitable for testing diodes, since one cannot measure the mutual conductance of anything which has no control grid.

A HIGH-FIDELITY AMPLIFIER

"E.S.R.," Auckland, writes asking whether we have printed a circuit which is not too expensive to build, but which will give high-fidelity results and which will eliminate as much record scratch as possible.

We think that our correspondent is under rather a misapprehension in that no amplifier, as such, is capable of suppressing record scratch. This noise covers a wide slice of the audio range, and the only method of eliminating it is to severely attenuate the high-frequency response of the amplifier, which immediately brings it out of the high-fidelity class, because the high audio frequencies from the record are as severely atteunated as the scratch. In other words, there is really no cure for record scratch, except to take some precautions in buying a gramophone pick-up to see that it has not got a rising response to high frequencies. A pick-up with a rising response like this accentuates the bulk of the frequency range that is covered by the scratch and makes the latter much more pronounced than it should be. A certain amount can be accomplished by the judicious use of a control which gives progressive attenuation of the highs, but this is undesirable, as stated above. It is not generally realized that most pick-ups in the low-priced class have an undesirable resonance somewhere near 4000 or 5000 cycles per second. This causes the scratch to be very much exaggerated, and it is surprising how little scratch actually comes off a good record when the pick-up either has a flat high-frequency response, or else has a gradual roll-off above 5000 c/sec., with no peaks of any kind.

We would suggest that one of the best amplifiers we have published for a long time is the "New High-quality Audio Amplifier," described in "Radio and Electronics" of June, 1949.

THE "NEW HIGH-QUALITY AUDIO AMPLIFIER"

"J.H.McC.," Wanganui, informs us that he has built our latest amplifier, which was described under the above title in "Radio and Electronics" of June, 1948. He has also incorporated in it the "Versatile Tone Control," which was described in the July, 1949, issue. The tone control circuit has been placed between the first stage and the second, which is the phase inverter, and our correspondent has noted that, since adding the tone control circuit, the effectiveness of the negative feedback seems to be much reduced, as judged by shorting out the feedback and noting the gain increase. He asks whether the addition of the tone-control will therefore have reduced the effectiveness of the feedback as far as its distortion-reducing properties are concerned.

J.H.McC. has a further query concerning high quality at medium output levels. Do we think, he asks, that a circuit of simpler construction than the one we have been discussing might give similar results at lower power outputs. For instance, if the cathode followers were eliminated, reducing the tube complement by one, would the bass and treble response be worsened, and, if so, could the bass and treble boost control be used to compensate for this?

Taking these questions in order, we may say that what our correspondent has noticed is just what might be predicted from what he has done. There can be numerous pitfalls in modifying the design of feedback amplifiers, and this is one of them. It is well known that one of the effects of negative

feedback is to flatten out the frequency response curve. That is to say, if the amplifier response, without feedback, exhibits a drop or a rise, the application of feedback will cause this drop or rise to be less pronounced, and the response curve as a whole to become flatter. This is a very desirable characteristic of feedback amplifiers, and one that is often taken advantage of. However, it does limit to some extent what can be done in that part of the amplifier which is within the feedback loop. That is to say, if we wish intentionally to produce a rising or falling frequency response, as we do when we employ a circuit such as the "Versatile Tone Control" which enables us to either boost or cut the highs or lows, or both, any circuit which is intended to do this must not be included within the feedback loop. If this is done, the feedback does its best to nullify the very effect that the tone control circuit is producing. As a result, the control circuit becomes very much less effective than it should be.

This result has not been noticed by our correspondent, apparently, but in his case it is probably masked by the other main effect, which he has told us about. It is this, that placing a tone-control circuit between two valves reduces the overall gain of the amplifier because the control circuit itself has a quite large insertion loss. If it did not, it would not be able to give any boost. Now, the measure of the effectiveness of an inverse feedback arrangement is the degree of gain reduction that is apparent when the feedback is connected. The amount of gain reduction itself depends on two things: (1) the percentage of the output voltage that is fed back to the input, and (2) the voltage gain that occurs between the points between which the feedback voltage is picked off and re-inserted in the amplifier. Now, placing the tone-control between these points (that is, within the feedback loop) causes the voltage gain within the feedback loop to be reduced, so that, if the same percentage of the output voltage as before is fed back to the input, the gain reduction will be reduced.

There is only one cure for this, and that is to remove the tone-control circuit from within the feedback loop, leaving the amplifier as originally designed, and then to place the tone-control network between the input terminal and the first valve. The reduction of gain will still occur, but the effect on the feedback will not, and neither will the effect on the performance of the tone-control. If it is found that the loss in the latter is too great, it will be necessary to add a further stage of amplification, and to place the volume-control at the grid of this additional stage.

The second question can be answered as follows. It would be possible to eliminate the cathode follower stage with only a comparatively slight effect

(Continuel on page 48.)

Condenser Leakage and its Effects

BY THE ENGINEERING DEPARTMENT, AEROVOX CORPORATION

Servicemen, engineers, and experimenters are generally supplied with instruments which will tell them whether a condenser is shorted or open and what the capacity is. Yet this tells not enough and there is a trend towards more complicated condenser testers which will give an indication of insulation resistance or leakage. Assuming that such an instrument were available, where shall we set our minimum of insulation resistance—in other words, how much shall we let it leak?

Some people have set a limit with the result that servicemen have found that certain condensers which should be unsatisfactory according to this rule, are still performing their duty perfectly. Also, there are condensers which test O.K. and yet do not give satisfactory service. As a matter of fact, a single practical limit cannot be given, since it will vary with the service the condenser has to perform. There are condensers which have to satisfy very rigid requirements in regard to leakage and there are others which may have some leakage without causing any harm. It all depends on where these condensers are to be used. It is the purpose of this article to point out the reason for this strange fact and to calculate the effect of a given insulation resistance on the performance of condensers used in various circuits of a radio receiver.

First it is necessary to remember that a "perfect" condenser of the tubular (paper dielectric) type may have an insulation resistance of 15000 megohms. When

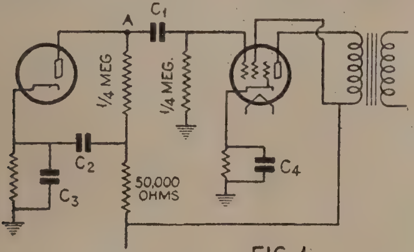


FIG. 1

the outside carton is damp, this may decrease to 1000 megohms. If the leakage of a condenser is *very* bad, the insulation resistance may fall to 100 megohms. It will be shown that so low a resistance will be fatal for certain uses of a condenser, but for others it is quite unimportant.

That the leakage has very little to do with bypassing efficiency has already been shown in the Research Worker for October 1934 but we shall return to this later. First, this discussion should be restricted to D.C. phenomena caused by leakage.

CRITICAL LOCATIONS OF A CONDENSER

Blocking condensers are used in resistance coupled amplifier circuits in order to prevent the high voltage from reaching the grid of the next amplifier tube. This is illustrated in Fig. 1, where a voltage amplifier tube is resistance coupled to a power pentode. C1 is the condenser in question. Suppose that the current drawn by the voltage amplifier tube is .2 ma, then the voltage drop in the load resistance and the filter resistance will be

$$300{,}000 \times .0002 = 60 \text{ volts}$$

The voltage at the point A is then 300 — 60 =240 volts with respect to the chassis. When C1 has some leakage, it can be considered as another resistor for purposes of D.C. calculations. The remaining 240 volts will now divide across the condenser and the gridleak in direct proportion to their resistance. In general, the leakage current will be small in comparison to the current drawn by the voltage amplifier tube. It shall be considered that the voltage at the point A does not vary appreciably. In that case, the voltage drop across the gridleak will be

$$E = \frac{1}{4\,L} \times 240 \text{ volts}$$

where L is the leakage resistance. Substituting for L values of 15,000 megohms, 10,000 megohms, 500 megohms, 100 megohms and 50 megohms, the corresponding values of E are:

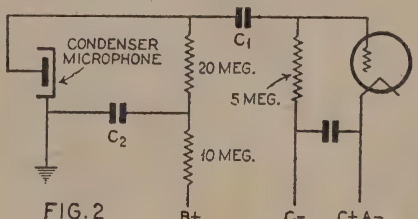


FIG. 2

L	E
15000 meg	.004 volts
10000 meg	.006 volts
1000 meg	.06 volts
500 meg	.12 volts
100 meg	.6 volts
50 meg	1.2 volts

The voltage E is applied to the grid in opposition to the bias and causes an increase in plate current as well as easier overload of the tube, accompanied with distortion. The example just quoted is one of the most favourable (for the condenser) because the gridleak had so low a value. But suppose the next tube had been a voltage amplifier tube, with a gridleak of 1 or 2 megohms and a bias of but 3 volts. *If the gridleak is 1 megohm, the values of E become four times as high as in the previous example, in the case of a 2 megohm gridleak they become eight times as high. An insulation resistance of 100 megohms would then place a positive voltage of 4.8 volts on the grid in opposite sense to the grid bias. If the bias were 3 volts, this would leave the grid 1.8 volts positive. Even 500 megohm insulation resistance will cause trouble in this case.* It is clear that the higher the voltage at A and the higher the value of the gridleak, the higher will be the positive voltage applied to the grid.

An even more critical service for a blocking condenser is in the pre-amplifier for a condenser microphone. This circuit is illustrated in Fig. 2. These are very high resistance circuits and the B voltage might be very high—up to 500 volts. Assuming that the voltage of the B supply is again 300 volts and that the condenser C2 does not have any leakage, the drop across a 5 megohm gridleak would be

$$E = \frac{5}{L - 35} \times 300 \text{ volts}$$

Substituting again several values for L, we have:

L		E
15000 megs		.1 volt
10000 megs		.15 volt
5000 megs		.3 volt
1000 megs		1.5 volt

The tube used in this circuit, probably has a bias of but 1.5 *volts which makes a condenser of* 1000 *megohm insulation resistance useless.* Yet this same condenser could still be employed with the power tube circuit of Fig. 1. This also illustrates why the blocking condensers in such pre-amplifiers must be protected against moisture.

Another critical location for a condenser is in A.V.C. circuits because resistances are high. A typical circuit is illustrated in Fig. 3; it shows a circuit where the second diode plate takes care of the A.V.C. circuit and is independent of the diode detector. The resistor values of R1 and R2 are generally in the neighbourhood of ½ to 1 megohm. In order not to lose any of the previous

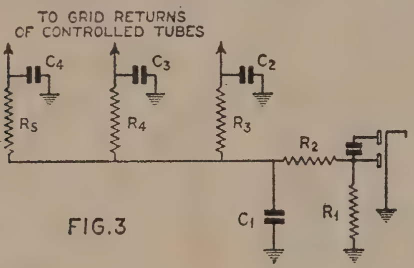


FIG.3

A.V.C. voltage the total leakage of C1, C2, C3, and C4 should be small, the total resistance should be large compared to R1, say 100 times as much. This would set a lower limit of 400 megohms for each condenser. Perhaps a greater loss than 1 per cent. is permissible, but this service requires good condensers.

NON-CRITICAL LOCATIONS OF CONDENSERS

Condensers used for bypassing plate, screen, and cathode circuits do not have to satisfy such rigid requirements and sometimes the insulation resistance can be quite low without any trouble turning up. The condenser C2 in Fig. 1 for instance, when passing any current will pass this current through the bias resistor of the voltage amplifier tube, thereby raising the bias. The value of this resistor might be as high as 5000 ohms. The increase in bias due to this cause would then be

$$E = \frac{5}{1000\ L} \times 300 \text{ ohms}$$

where L is again the insulation resistance. In this equation the drop across the 50,0000 ohms has been neglected for convenience sake. This does not cause any serious error. Substituting values for L, we find

L		E
15000 megs		.0001 volt
1000 megs		.0015 volt
100 megs		.015 volt
10 megs		.15 volt
1 meg		1.5 volt

If the bias resistor had half the resistance of 5000 ohms, these figures for E will be half as much. It is seen that although the magnitude of E is much smaller for a given leakage, *the practical limit is somewhere near* 100 *megohms.* If C2 had been connected from the B supply to the chassis, instead of to the cathode this effect of raising the bias would not take place no matter how much leakage there was. In such a case the amount of current should be considered, this is generally very low and would not upset the operation of the receiver as long as the current itself is not sufficient to raise the temperature of the condenser thereby hastening its destruction. If the plate supply voltage is 300 volts, the following table shows the current drawn by condensers of different insulation resistance and the third column shows the amount of power dissipated.

L	I	P
15000	.02 micro amp	6 microwatts
1000	.3 micro amp	90 microwatts
100	3. micro amp	.9 milliwatts
10	30. micro amp	9 milliwatts
1	.3 ma	.09 watts

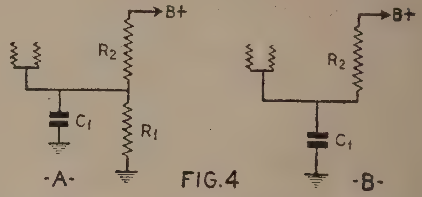


FIG.4

This table is for a 300 volt potential difference across the condenser. The current is of course proportional to this voltage and the power is proportional to the square of the voltage.

The case of C3 and C4 is again a bit different. These condensers are connected across low voltages and their leakage is not important even when the insulation resistance is as low as 1 megohm. In fact, electrolytic condensers are quite customary for the service of C4.

There remains the use of condensers in the screen supply circuit, illustrated in Fig 4. They are customarily used in two ways as at A and at B.

At A the condenser C1 is connected across the lower half of a voltage divider. If this voltage divider does not supply any other circuit but that screen, its resistance may be quite high, sometimes as much as 50,000 ohms. Placing a leaky condenser across it amounts to lowering the effective value of R1 and lowering the screen voltage. It becomes rather tedious to compute the exact amount of this variation, but it can be seen, that a 1 megohm resistor across R1 would lower the total resistance only 5 per cent. and the screen voltage by less than that.

The circuit of B requires somewhat better condensers for the value of R2 may be as high as one megohm. A condenser with an insulation resistance of 100 megohms (a bad one) will not cause any appreciable drop in screen voltage, but one of 10 megohms would.

CONDENSERS IN R.F. AND A.F. CIRCUITS

So far, the standpoint of direct current only was considered. However, condensers C2, C3, and C4 of Fig. 1 pass A.F. currents and the condensers in Fig. 3 pass R.F. currents. It might be thought that an amount of leakage which was found to be harmless in our previous discussion may cause trouble due to less efficient filtering or losses in the R.F. circuit. To be sure, there is such a loss but it is so small that it is negligible compared to the reactance in the circuit and compared to the D.C. resistance of I.F. coils.

The equivalent series resistance for a given shunt resistance is found from the equation

$$R_s = \frac{X_c^2}{R_{sh}}$$

Taking the case of Fig. 3, when the condensers have a capacity of .1 mfd. and the frequency might be 450 kc., the reactance of the condenser is

$$X_c = \frac{1000000}{2\pi fC} = \frac{1000000}{6.28 \times 450000 \times .1}$$
$$= 3.5 \text{ ohms approx.}$$

Substituting this value in the above equation and taking various values for the shunt resistance (insulation resistance), the following equivalents are found

15000 megs	.000 000 000 81 ohms
1000 megs	.000 000 012 ohms
100 megs	.000 000 12 ohms
10 megs	.000 0012 ohms
1 meg	.000 012 ohms

These resistance values are negligible compared to the resistance of the coil.

In A.F. circuits, the reactance of the condenser is larger and consequently the effect is somewhat more pronounced, but the series resistance is still very small compared to the reactance of the condenser. For instance, let the bypass condenser have a capacity of 1 microfarad and let the frequency be 100 cycles, then the reactance is 1600 ohms. Substituting this value in the equation again and finding the equivalent series resistance:

R shunt	R series
15000 megs	.000 17 ohms
1000 megs	.002 6 ohms
100 megs	.026 ohms
10 megs	.26 ohms
1 meg	2.6 ohms

When expressed in power factor, the last and worst shunt resistance comes to .16 per cent.

It is believed that the above examples are sufficient to prove our point as well as to enable the reader to calculate the result of leakage in other circuits he might encounter.

SUMMARY

1. Insulation resistance has a very small bearing on power factor, practically negligible even when the insulation resistance has come down to very low values. When a bad power factor is present, it is due to other causes, not to leakage.
2. All difficulties due to leakage are D.S. phenomena, mostly because the leakage current is added or subtracted from the current through some resistor which controls the voltage at a tube element.
3. Due to the varied uses of condensers, it is impossible to set up fixed limits for the insulation resistance. They would have to be determined for each service individually.
4. The highest requirements for condensers are encountered in circuits where they are connected in series with relatively high resistances.
5. It was shown how the effect of leakage can be calculated in various circuits which will enable the user to establish his own lower limits of insulation resistance in each individual case.

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AUDIO EQUIPMENT AND DESIGN:

When Negative Feedback Isn't Negative. Clear explanation of principles involved in negative feedback design. Effects caused through faulty design. Suggestions for eliminating self-oscillation in amplifiers using negative feedback.
—Wireless World (Eng.), May, 1949, p. 189.

Contrast Expansion. General discussion, and circuits of (a) controllable gain amplifier using pentagrid valve; (b) cross-connected pentodes to eliminate distortion due to changing anode current; (c) cathode-follower in contrast expander; (d) contrast expander by application of negative feedback; and (e) expander using modification of negative feedback control design.**—Wireless World (Eng.), June, 1949, p. 211.**

A Continuously Variable Equalizing Pre-amplifier. Circuit of pre-amplifier; has two phono inputs and cathode-follower output. Uses 6SC7 double triode input, 6SF5 triode amplifier, and 6SL7 double triode, one portion of which acts as a feedback summing amplifier and other portion as C.F. output triode. Response curves illustrated.
—Audio Engineering (U.S.A.), April, 1949, p. 14.

Compact 6AS7G Amplifier for Residence Audio Systems (Part 2). Further details of construction of two-unit amplifier, with suggested modifications for use with 6v. filament valves.
—Audio Engineering (U.S.A.), April, 1949, p. 16.

A Three-dimensional Reproducer System. Circuit of three-valve volume expander, a three-valve wide-range compressor, a frequency discriminator system for use with an expander or compressor, and a 40-watt, dual-channel (for two loudspeakers) amplifier and volume expander. 6L6 output; separate power supply for screen of power valves and driver stages.
—Radio News (U.S.A.), June, 1949, p. 44.

Audio Transient Distortion. Circuit of a low-powered amplifier using bridge-type feedback in voice coil circuit, with provision for variable feedback control. Unit intended to compensate for limited loudspeaker transient response. 6B4 or 6L6 output. Suggestions for adjustment.
—Radio News (U.S.A.), June, 1949, p. 46.

A Compact Low-frequency Baffle. Description and constructional details of a baffle of less than two cubic feet in content, with bass response to below 60 c.p.s., suitable for use when moderate sound levels are desired and when space does not permit of use of a larger baffle. Combination of "infinite" baffle and acoustic labyrinth.
—Radio News (U.S.A.), June, 1949, p. 56.

ANTENNAE AND TRANSMISSION LINES:

What! No Antenna? Eight practical suggestions for indoor transmitting antennae.**—QST (U.S.A.), June, 1949, p. 15.**

The V.H.F. Sandwich. Particulars of construction and dimensions of the stacked arrays. Two 4-element arrays, stacked, four 50 mc. and, in space between, two stacked 4-element arrays for 144 mc. Feed systems described.
—QST (U.S.A.), June, 1949, p. 36.

Inverted Rhombics and Biconical Beams. Description of antennae for T.V. work but applicable to amateur purposes.
—QST (U.S.A.), June, 1949, p. 42.

An Experimental All-band Non-directional Transmitting Antenna. Description of an aperiodic system giving uniform output over a frequency of approximately a 5/1 ratio, with non-directional characteristics. Antenna is a tilted folded dipole.
—QST (U.S.A.), June, 1949, p. 54.

CIRCUITS AND CIRCUIT ELEMENTS:

Low-frequency Discriminator. Circuit designed for the purpose of maintaining a specified frequency separation between two R.F. oscillators which would normally either drift apart or lock. A phase inverter with equal anode and cathode loads feeds a resistance-capacitance phase shifter, and circuit functions as a discriminator without the necessity for transformers and without resonant circuits.
—Electronics (U.S.A.), June, 1949, p. 96.

Cathode-follower Bandwidth. Nomograph relates bandwidth (—3 db. point), output resistance, and output capacitance for cathode-follower operation.
—Electronics (U.S.A.), June, 1949, p. 114.

Single-valve Frequency Modulated Oscillators (Part 2). Discussion of practical details of design and use of circuits, operation of which was previously described. (**Wireless World**, April 1949, p. 122; see **Radio and Electronics Abstracts**, August, 1949.) Application to "wobbulators" for receiver alignment.**—Wireless World (Eng.), May, 1949, p. 168.**

Electronic Circuitry. (a) Twofold coincidence circuit suitable for operation in conjunction with Geiger-Muller tubes to fix direction, and with other more common applications; (b) simple time-base circuit using two triodes in variation of cathode-coupled multivibrator circuit. Also suitable for pulse generator.
—Wireless World (Eng.), May, 1949, p. 187.

Parasitic Oscillations. Discussion of causes. Circuits in which parasitic oscillation may be set up are illustrated and with reference to these is stressed the necessary care in construction and assembly of equipment.
—Wireless World (Eng.), June, 1949, p. 206.

Electronic Circuitry. Simple, reliable circuit of scale-of-two counter and of cathode-follower buffer to be used with it.
—Wireless World (Eng.), June, 1949, p. 225.

Blocking Oscillators. Reasons for unsatisfactory operation of blocking oscillator as sawtooth generator in oscilloscopes when used at high repetition frequencies. Circuits of modified blocking oscillators with provision for neutralization to overcome deficiencies described.
—Wireless World (Eng.), June, 1949, p. 230.

Voltage Stabilizers (Part 2). Principle of stabilization, using gas discharge tubes. Table of characteristics of available tubes. Reference to disadvantages of neon-type tubes. Circuit given for stabilizers employing thermionic valves.
—Electronic Engineering (Eng.), June, 1949, p. 200.

Harmonic Content of Multivibrator Waveforms. Mathematical treatise giving quantitative data for amplitudes of component harmonics comprising output of multivibrator; also an indication of manner in which harmonic content changes as waveform is modified.
—Electronic Engineering (Eng.), June, 1949, p. 214.

Graphic Analysis of Diode Circuits. Consideration of case in which grid of a triode or pentode, condenser-coupled input, takes grid current and rectification occurs. Analysis deals with wave shape distortion in these circumstances and the degree of rectification.**—Wireless Engineer (Eng.), May, 1949, p. 147.**

Oscillation Amplitude in Simple Valve Oscillators. Derivation of method for calculating steady-state value of oscillation amplitude, or alternating grid voltage, in simple valve oscillators, regenerative type with grid bias. Types of amplitude instability studied. Subject to certain conditions, analysis applies to all common types of oscillator circuit. First part of article.
—Wireless Engineer (Eng.), May, 1949, p. 150.

Oscillator Amplitude in Simple Valve Oscillators (concluding article). Deals with determination of amplitude when (a) periodic and (b) aperiodic instability present. Consideration of causes of periodic instability (squegging).
—Wireless Engineer (Eng.), June, 1949, p. 201.

FREQUENCY MODULATION:

Distortion in F.M. Explanation of causes of distortion in I.F. stages of F.M. receivers, due to effect of tuned anode circuit.
—Wireless World (Eng.), June, 1949, p. 218.

MATERIALS AND SUBSIDIARY TECHNIQUES:

Carbon Resistors. Review of current types and their characteristics.
—Wireless World (Eng.), June, 1949, p. 2 (Supplement).

Choosing Capacitors. Properties and uses of the various types.
—Wireless World (Eng.), June, 1949, p. 5 (Supplement).

Polytetrafluorethylene. Description of a new insulating material which has the advantage of not suffering from softening and becoming mechanically unstable at high temperatures, as does polyethylene.
—Wireless World (Eng.), June, 1949, p. 10 (Supplement).

Plastic Film Capacitors. Advantages described of using polystyrene as dielectric.
—Wireless World (Eng.), June, 1949, p. 11 (Supplement).

R.F. and Television Cables. Use of polythene as insulating material. Enumeration of advantages over other insulators for purposes stated.
—Wireless World (Eng.), June, 1949, p. 16 (Supplement).

Magnets for Radio. New alloys and their use in loudspeakers, microphones, pick-ups, magnetic recorders, and Magnetron oscillators.
—Wireless World (Eng.), June, 1949, p. 16 (Supplement).

Multiple Component Units. Description of methods of incorporating elements such as resistors and condensers in one unit to facilitate assembly and reduce number of connections. Units are applicable to either printed circuit technique or orthodox methods of manufacture.
—Electronic Engineering (Eng.), June, 1949, p. 199.

Hermetically Sealed Transformers. For export, British equipment is designed to function satisfactorily in widely varying climatic conditions. Article considers effects of moisture on open transformers, general requirements of hermetically-sealed transformers, such as design factors, assembly, and future developments.
—Electronic Engineering (Eng.), June, 1949, p. 218.

MICROWAVE TECHNIQUES:

Standard for Waveguides. Radio Manufacturers' Association (U.S.A.) has fixed new commercial standard for rectangular waveguides, to give close control of outside and inside dimensions. Table of dimensions, tolerances, and frequency range for rigid rectangular waveguides.
—Electronics (U.S.A.), June, 1949, p. 111.

Attenuation in Waveguides. Power handling capabilities and attenuation for the $TE_{1,0}$ mode in rectangular waveguides standardized by R.M.A.
—Electronics (U.S.A.), June, 1949, p. 112.

Earthed-grid Power Amplifiers. First part of article dealing

with use of this type of amplifier in V.H.F. sound and vision transmitters. Details of practical operation of three specified types of English valve designed for use with earthed-grid amplifiers. (Types CAT21, ACT26, and ACT21.) Suggested practical circuit for grid-modulated earthed-grid amplifier driven by R.F. cathode-follower. Frequency range, 41-66 mc.
—**Wireless Engineer (Eng.), June, 1949, p. 182.**

Transit Time Effects in U.H.F. Valves. Examination of some simpler transit-time phenomena. Suggested mathematical technique applicable to cases where space-charge distortion of electrostatic field may be neglected.
—**Wireless Engineer (Eng.), June, 1949, p. 192.**

Microwave Calorimeter. Description of commercially made (U.S.A.) instrument enabling measurement of absolute R.F. power at frequencies between 2,600 and 26,500 mc. Principle of operation is measurement of rise in temperature of water circulating in waveguide.
—**Radio News (R-E. Eng. Ed.), June, 1949, p. 15.**

MEASUREMENTS AND TEST GEAR:

R.F. Coil Design Using Charts. R.F. solenoid-design nomograph, with accompanying chart, enables R.F. coils to be designed without recourse to mathematical calculations. Given capacitance, resonant frequency, and size of coil form, inductance, and number of turns may be ascertained. Range, 0.1 to 100 mc.—**Communications (U.S.A.), May, 1949, p. 10.**

Nomograph Design for H.F. Heating Circuits. To enable determination of tank circuit constants of output stage of H.F. heating equipment for optimum operating conditions. Applicable to either induction or dielectric-heating circuits.
—**Radio News (R-E. Eng. Ed.), June, 1949, p. 18.**

RECEPTION AND RECEIVERS:

Modernizing the Pre-war H.R.O. Modernization comprises revision of H.F. oscillator by incorporation of temperature compensation; revision of second detector circuit and first audio stage. Addition of a noise limiter and inclusion of an antenna shorting relay.—**QST (U.S.A.), June, 1949, p. 51.**

TELEVISION:

Minimizing Television Interference. Mention of the main types of T.V.I. and practical remedies. Methods outlined for improving sensitivity and selectivity of receivers, thereby increasing the range—**Electronics (U.S.A.), June, 1949, p. 70.**

Cathode-compensated Video Amplification. Part 1. Application of feedback obtained in cathode circuit of a video amplifier to produce improvement in linearity, constant amplitude—within reasonable limits—and time delay over the useful frequency range of operation. First part of article deals with theoretical analysis of circuit and experimental verification.
—**Electronics (U.S.A.), June, 1949, p. 98.**

Cathode-ray Tubes for Television. Operating conditions v. picture brightness. Resolution of two problems, one relating to necessary increase in C.R. tube voltage to maintain constant brilliance as screen diameter is increased, assuming (a) constant resolution at screen and (b) constant spot size. The other problem is determination of necessary increase in tube voltage as number of scanning lines is increased, for frame frequency.—**Wireless World (Eng.), June, 1949, p. 202.**

Television Time Base Linearization. A number of circuits suggested for the purpose of achieving, as nearly as possible, linear scanning. Circuits applicable to any case where it is desired to linearize an exponential voltage, or a current change. Correcting circuits are applied to sawtooth generators. Where amplifiers (voltage or current) follow the sawtooth generator, correction may be introduced at a later stage.
—**Electronic Engineering (Eng.), June, 1949, p. 195.**

Video Amplifier Testing Using a Square Wave Generator. Explanation of necessity for linearity in amplitude and phase characteristics, from zero to infinite frequency, in video amplifiers. Plotting of phase shift v. frequency response permits, from inspection, an estimate of response to video signal, but near high- and low-frequency cut-off transient performance is still undeterminable. Use explained of square-wave generator for determination of high- and low-frequency transient responses. Circuit given for suitable square-wave generator. Effects on square-wave of various types of distortion illustrated.—**Electronic Engineering (Eng.), June, 1949, p. 204.**

Modern Television Receivers (Part 15). Further notes on inter-carrier T.V. systems; advantages and disadvantages.
—**Radio News (U.S.A.), June, 1949, p. 41.**

TRANSMISSION AND TRANSMITTERS:

A Low-cost Bandswitching V.F.O. Covers all amateur bands below 30 mc., with single external multiplier stage. Unit has 7C5 in Clapp circuit and 7C5 doubler. By incorporation of crystal, second 7C5 may be operated as crystal oscillator. Output suitable for driving either 6L6 or 807 valve.
—**Radio News (U.S.A.), June, 1949, p. 34.**

A Super-modulated, Low-power Phone Transmitter. Circuit and construction of a radio telephone transmitter using Taylor system of super-modulation. 807 valves used in R.F. amplifier and modulator stages. 6B4 valve in audio driver stage and 6L6 in R.F. driver stage.
—**Radio News (U.S.A.), June, 1949, p. 50.**

Miniature Phone-C.W. Transmitter for Portable Use. Circuits and construction of a transmitter built into two interlocking cabinets, one cabinet containing R.F. section and the other the modulator. R.F. section uses 6AG7 crystal oscillator, 6AG7 buffer-doubler, 815 amplifier. Modulator also has 815 valve in final stage.—**Radio News (U.S.A.), June, 1949, p. 61.**

V.F.O.'s for Phone or C.W. Circuits and constructional details of two V.F.O. units, both employing Clapp oscillator.
—**QST (U.S.A.), June, 1949, p. 11.**

Multiple-Circuit Tuners from Grid to Feeders. Circuit and construction of a six-band R.F. amplifier and antenna coupler combined in one unit, for rapid band-changing. 807 Valves in output.—**QST (U.S.A.), June, 1949, p. 25.**

A Filter Design for the Single Sideband Transmitter. Design considerations; details of construction of toroidal-type coils and filter alignment. Circuit of 30 kc. oscillator and balanced modulator suitable for use witr the filter described.
—**QST (U.S.A.), June, 1949, p. 29.**

VALVES:

Planar Electrode Valves for the U.H.F. Description of types of experimental triodes developed for U.H.F. work and intended to have more general application than disc-seal type. New valves are mounted in pressed glass boxes, with pins forming the lead-in wires.
—**Wireless World (Eng.), May, 1949, p. 165.**

MISCELLANEOUS:

Audio Smoke Alarm. Circuit and description of a simple piece of apparatus which indicates aurally the density of smoke in a particular location. Employs phototube and associated circuit to produce bias for blocking oscillator which at predetermined smoke level is inoperative. Increase in density of smoke results in a decrease of bias and the oscillator functions at a low audio frequency Oscillations are amplified and fed to loudspeaker. As smoke density increases, bias decreases still further, with the result that pitch and intensity of signal increase.
—**Electronics (U.S.A.), June, 1949, p. 77.**

Pick-up Placement. Equations for determining best mounting position for tone arm used with records which have groove radii different from those for which arm is intended.
—**Electronics (U.S.A.), June, 1949, p. 87.**

Adjacent Channel Operation of Mobile Equipment. Consideration of methods, such as suitable design of equipment and proper geographical placing of transmitters, whereby full and economical use may be made of V.H.F. spectrum.
—**Electronics (U.S.A.), June, 1949, p. 90.**

THE P.44

CELESTION

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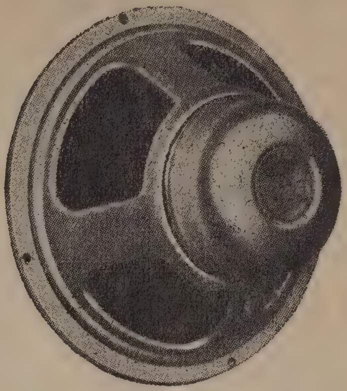

A lightweight, relatively inexpensive speaker possessing the full bodied bass response normally associated with more costly 12-inch speakers, together with a particularly clean and smooth upper register. This model can advantageously replace a 10-inch speaker in most radiogram applications.

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Designed to handle the intricate problems of modern radio work, this latest "Avo" Signal Generator has wide range and extreme accuracy in performance. Turret coil switching provides six frequency ranges covering 50 kc/s. to 80 mc/s. All ranges are fundamentals. A unique system of illuminated range and tuning indication ensures no ambiguity of scale reading. Switching is provided to enable modulated or unmodulated R.F. signals to be obtained, modulation being provided to a depth of 30 per cent. by a 400 c/s. signal of good waveform.

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Range 3	500	kc/s.	to	1.5	mc/s.
Range 4	1.5	mc/s.	to	5.5	mc/s.
Range 5	5.5	mc/s.	to	20	mc/s.
Range 6	20	mc/s.	to	80	mc/s.

"AVO" MEANS ACCURACY

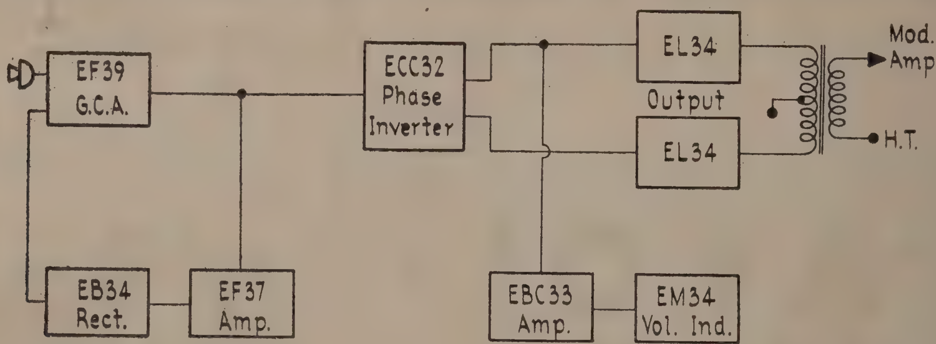
The PHILIPS Experimenter

No. 23: A SPEECH AMPLIFIER AND MODULATOR FOR THE PHILIPS TRANSMITTER

Having completed the description of the final amplifier, we have now finished with the R.F. section of the transmitter, and find ourselves with a V.F.O., exciter, and final amplifier, capable of putting approximately 75 watts of R.F. into an aerial on any frequency in any amateur band from 80 to 10 metres, inclusive. This and the next issue of the "Experimenter" will be devoted to the electrical and mechanical details of the speech-amplifier and modulator, which will be capable of modulating 100 per cent. the plate and screen of the QQEO6/40 final.

In our opinion, modulation equipment, as represented by the average amateur's speech amplifier and high-powered modulator stage, is deserving of a good deal more care in design than is usually given it. There still seems to be a tendency to regard modulation gear as something too simple and straightforward to be worth much consideration, especially since the fidelity requirements are for "speech only." The latter phrase is rather unfortunate, because, although it does typify a very real relaxation of standards as compared with the same sort of equipment when intended for high-quality music, it also tends to give the entirely false impression that anything is good enough if it is to be used only for speech. While it is quite true that extended frequency range is neither necessary nor desirable for this purpose, and also that if intelligibility is the sole criterion, then a higher percentage distortion can be tolerated in speech reproduction than for music, this does not mean that little consideration need be given to designing the audio section of our transmitter for low distortion, nor that we need not worry what the frequency response may be like. Again, we must take precautions against over-modulation, with its attendant distortion of our own signal and interference with the next man's. In addition, we want, if possible, to take advantage of the fact that speech waveforms are asymmetrical, and by so doing ensure that the maximum possible proportion of the transmitted power goes into the sidebands, which are the only part of the signal which carry the intelligence we wish to convey. When all these things are added up, we find ourselves with rather more than just a high-powered audio amplifier.

In designing this unit of the transmitter, we have attempted to give examples, not of the best possible way of accomplishing the things indicated above, but of ways in which they can be done without any great trouble or expense. Some of the circuitry we have already described as separate units in previous "Experimenters," and since they worked very satisfactorily before, we have seen no reason to change them. We refer to the amplitude compresser, or automatic gain control, and also to the level indicator circuit. Full descriptions of these parts of the circuit will be found in "Experimenter No. 9" and "Experimenter No. 1" respectively, and readers are referred to these articles if fuller descriptions are wanted than we have space for here.



Block diagram of the speech frequency circuits.

THE MODULATORS

For the modulators, we have chosen a new Philips pentode, the EL34. This valve is intermediate in size between the EL35 and EL37, and has characteristics very similar to, but not identical with, those

of the 6L6. The use of the EL34 as a replacement for the latter type will be dealt with at a later date in the Philips Application Notes, so we will not enlarge on it here. Suffice it to say that a pair of EL34's in Class B1 are capable of an output power of 58 watts, with a total distortion of 4.5 per cent., and without the application of negative feedback. Because of this, we have chosen this valve for the modulators. The design of the high-powered stage is considerably simplified by the fact that the EL34's draw no grid current (as indicated by the name Class B1), so that normal resistance-capacity coupling can be used in their grid circuits. Because of the very large swing in plate and screen current when loaded, it is not possible to use cathode bias, but here, again, a useful characteristic of the EL34 comes to our rescue. In this class of service, the maximum allowable grid resistance per valve is 500,000 ohms, which is remarkably high for a large valve with fixed bias. Older valves required a much lower resistance in the grid circuit when operated with fixed bias, so that R-C coupled drivers were difficult to apply. Here, however, the allowable value of 500k. makes normal R-C coupling possible, and we have chosen the ECC32 as a very suitable phase-inverter and voltage amplifier, which drives the grids of the EL34's directly. The fixed bias on the EL34's is 42 volts, so that, allowing, say, 1 volt for contact potential, a peak signal of 41 volts is needed for each valve. This voltage is well within the capabilities of the ECC32 to supply, with very small distortion, so that the choice of a driver valve is seen to be a good one.

The power requirements of the EL34's are a little

(Continued on page 38.)

Beacon Technical Topics No. 16

THE EFFICIENCY OF POWER TRANSFORMERS PART I.

Power transformer efficiencies range from 98.5% for a 100 KVA unit down to 65% or lower for a 5 VA unit, these figures being representative of common practice. It is the purpose of this and a following topic to indicate firstly how such high efficiencies can be obtained, and secondly why it is usual for the smaller type transformers to have considerably lower efficiencies than the transformers with greater power ratings.

The reason for the high efficiencies compared with the efficiencies of other types of electrical machinery is that a transformer has no moving parts. The total losses are therefore almost completely confined to the copper and iron, the remaining small amount being due to the insulation. Considering a converter, for example, having the same KVA rating as a large transformer, the above losses are present with the addition of friction, windage, and other limitations due to loading effects. It follows, then, that, due to these additional losses, the converter or any similar machine can never be made as efficient as a transformer handling similar power.

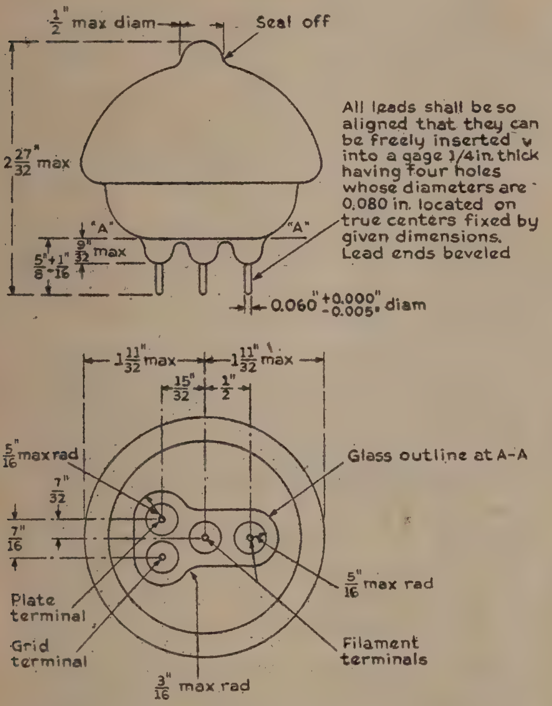
Dealing now with the second point—namely, low efficiency in the smaller type transformer: Since there are no moving parts, the limit to the loading of a transformer is the maximum temperature at which it is safe to operate the insulation. The temperature rise must therefore be governed so that it does not impair the insulation under working conditions. In practice, especially when making small transformers, the usual aim is to construct units of the smallest possible physical size for a given output power, at the same time keeping the maximum temperature rise within a safe limit. This is in contrast with the aim of constructing a transformer giving the same continuous output but having maximum efficiency regardless of physical size. Unless the specific aim is for maximum efficiency, efficiency is a consideration secondary to the problem of temperature rise.

It can be shown that the heat dissipation area decreases as the square of the equivalent spherical radius, whereas volume, and therefore total loss, decreases as its cube. Smaller transformers can therefore radiate more heat per unit volume than larger ones. For the same temperature rise, then, the smaller transformer can have a greater percentage loss of power. In other words, if a small transformer is designed to have the same maximum temperature rise as a large one, the small transformer will automatically have a poorer efficiency.

(To be continued.)

TUBE DATA

Recently, from the war-surplus stocks, quite a number of the famous Western Electric "doorknob" valves have come on the local market. We are pleased to publish the characteristics of this outstanding V.H.F. valve, which is capable of generating 7½ watts of power as an oscillator at 500 mc/sec.



Drawings showing physical arrangement of the VT191.

The VT–191 is a filamentary air-cooled triode designed for use as an ultrahigh-frequency oscillator and power amplifier. The tube develops a typical power output of 5 watts at a frequency of 500 mc. The frequency limit of oscillation is 750 mc.

General:

Filament voltage, 2 volts.
Fliament current, 3.65 amps.
Filament type, thoriated tungsten.
Average characteristic values calculated at Eb = 450 volts; Ib = 67 milliamps:
Amplification factor, 8.
Grid-plate transconductance, 2400 microhmos.
Direct interelectrode capacitances:
Plate to grid, 1.6 $\mu\mu$f.
Grid to filament, 1.1 $\mu\mu$f.
Plate to filament, 0.65 $\mu\mu$f.
Type of cooling, air.

THE W.E. 316A OR VT–191 DOORKNOB V.H.F. TRANSMITTING TRIODE

Plate-modulated Oscillator and Radio Frequency Power Amplifier—Class C (carrier conditions to which a modulation factor up to 1.0 can be applied):

Maximum D.C. plate voltage, 400 volts.
Maximum D.C. plate current, 80 milliamps.
Maximum D.C. grid current, 15 milliamps.
Maximum plate dissipation, 20 watts.

Oscillator and Radio-Frequency Power Amplifier—Class C (Unmodulated):

Maximum D.C. plate voltage, 450 volts.
Maximum D.C. plate current, 90 milliamps.
Maximum D.C. plate input, 36 watts.
Maximum D.C. grid current, 15 milliamps.
Maximum plate dissipation, 30 watts.

Oscillator and Radio-Frequency Power Amplifier (intermittent or keyed operation only; duration of operating period, 0.1 second maximum):

Maximum D.C. plate voltage, 1100 volts.
Maximum peak D.C. plate current, 250 milliamps.
Maximum average D.C. plate current, 25 milliamps.

Operation Precautions:

The VT–191 tube must not be subjected to appreciable mechanical shock or vibration. The thoriated tungsten filament of this tube is somewhat more fragile than the thoriated tunsten filaments of other transmitting tubes. These tubes should therefore be handled with more care to prevent filament breakage. In connecting to the terminals of the tube, care must be taken not to strain the glass. The tube may be supported from the terminals providing flexibility is maintained.

N.Z.E.I. NEWSLETTER

As a result of the courtesy of the Editor in granting the Institute publication space, many inquiries have been received from individuals desirous of linking up with the activities of the Institute. For the information, therefore, of prospective members there is reproduced below an extract from the rules governing the objects of the Institute and qualifications for admittance to membership.

SECTION 3: OBJECTS

The objects of the Institute are—

(a) To promote electronic science and all its applications and to encourage the spreading of electronic knowledge among the members.

(b) To promote understanding of the different specialized branches of electronic engineering and to bring into mutual association all those engaged in such branches of engineering.

(c) To initiate and encourage research and invention in electronics and to provide for the discussion of the results of such research and for their publication.

(d) To promote information in the science of electronics by discussions, examinations, books, papers, and correspondence with other bodies and individuals.

(e) To hold meetings, conventions, and exhibitions for readings, lectures, discussions, and demonstrations of ideas, theory, practice, inventions, and applications in all matters connected with radio and electronics science and applications thereof.

SECTION 5: MEMBERSHIP

Members.—A member shall be not less than 30 years of age, and the Admissions Committee may recommend as members—

(a) A registered engineer who has qualifications in electronics;

(b) A person who has been regularly educated in electronic knowledge and who has held a position of responsibility for at least ten years in connection with electronics;

(c) A person who has carried out research work of acknowledged importance in connection with electronics and who possesses acknowledged scientific qualifications.

Associate Members.—Every applicant for admission to the grade of Associate Member shall be not less than 28 years of age and shall satisfy the Admissions Committee on one of the following requirements:—

(a) That he has passed the Institute examination or has been exempted therefrom and that he has been engaged in work connected with electronics for a period of at least ten years;

(b) That he is a graduate of a University in science and has specialized in electronic subjects or that he is a graduate of a University in engineering, and that in either case he has had five years' experience in the application of electronics;

(c) That being a person educated in electronic knowledge he has had ten years' experience in the application of this knowledge and has submitted a paper or thesis which is acceptable to the Board of Examiners.

Associates.—Every applicant for admission to the grade of Associate shall be not less than 24 years of age and shall satisfy the Admissions Committee on one of the following requirements:

(a) That being a person engaged in electronic work he has passed the Institute examination for admission to this grade;

(b) That being a person engaged in electronic work he has passed an examination which is acceptable to the Admissions Committee for this grade;

(c) That being not less than 40 years of age and without examination qualifications he has knowledge of the theory and applications of electronic science of a standard acceptable to the Admissions Committee for this grade.

Students.—Every applicant for admission to the grade of Student shall be not more than 24 years of age and shall satisfy the Council that he is genuinely interested in electronics and is desirous of advancing his knowledge to enable him to qualify for transfer to a higher grade provided that if a branch shall request the age limit to be waived the Council shall have power to waive the same upon its being satisfied that any applicant or member so concerned is pursuing a course of study calculated to be of a standard to enable him to qualify within a reasonable period for transfer to a higher grade.

SECTION 7: ADMISSION

Application for admission to the Institute shall be made on a form to be supplied by the Institute and the form shall be completed in all relevant sections provided that the Admission Committee may recommend to the Council persons for election to the grade of Member; in all other cases—

(a) Applicants for the grade of Member shall be nominated by two members;

(b) Applicants for the grade of Associate Member shall be nominated by two corporate members;

(c) For membership in any grade other than corporate membership, the applicant shall be nominated by two members of higher grade than that for which application is made;

(d) The application form for admission to membership in the Institute shall contain an undertaking by the applicant that he agrees to be bound by the Rules and By-laws of the Institute in force at the time of his admission, also by those By-laws which may thereafter from time to time be made, and that he will endeavour to advance the objects of the Institute;

(e) Every application for admission shall be forwarded to the Secretary, who shall place the application before the Admissions Committee, save that an application for admission as a Student shall be placed before the Council;

(f) An approved applicant shall be admitted to the appropriate grade of membership on payment of such annual subscription as the rules may prescribe; until he is admitted, he shall not be entitled to any of the rights or privileges of membership;

(g) An applicant for advancement in the Institute from one status to another shall apply in such form and manner and comply with such conditions as may from time to time be prescribed by the Council;

(h) An applicant, upon being refused admission, may apply again after the next annual general meeting, provided that application is not made within six months of his being refused admission;

(i) In connection with any application, the Admissions Committee or the Council, as the case may be, may require information additional to that contained in the application form;

(j) An application for permission to submit a paper or thesis shall state the subject of the paper or thesis and be made on a form to be supplied by the Institute; the application shall be forwarded to the secretary, who shall place the same before the Admissions Committee; the form shall be completed in relevant sections irrespective of whether admission to the Institute is desired or transfer to a grade of membership.

SECTION 10: PRIVILEGES

(a) A member upon payment of his annual subscription is considered to have submitted himself to these presents

and on these conditions alone is entitled to the privileges afforded by the Institute;

(b) Except as may be specially provided for, herein, the rights and privileges of each member shall be personal to himself and shall not be transferable by his own act or by operation of law, and all such rights and privileges shall immediately cease upon his resignation or upon removal of his name from the register for any cause;

(c) Every member shall be entitled to a certificate of membership which shall remain the property of the Institute;

(d) Every member shall be entitled to a copy of any publications of the Institute upon such terms and conditions as the Council from time to time may determine.

(e) Every member shall be entitled to apply to his branch for advice in connection with any technical problem, and a record of any advice so given shall be made and a copy thereof shall be forwarded to the Council.

DISTRICT ACTIVITIES

AUCKLAND

Members are requested to give support to the lectures and demonstrations arranged for their benefit. All meetings are advertised in the Press, and increased attendances are looked for in the future.

A display of equipment was recently held, and the descriptions given by Messrs. Keith Hunter, Joseph, and Willis were most heartily appreciated by those present.

CHRISTCHURCH

A meeting of the Christchurch branch was held on 2nd August in the Electronics Lecture Room, Canterbury University College. Mr. E. Pratt, Senior Radio Inspector of the Christchurch Engineering District, gave an interesting talk on "Problems in Radio Interference."

Mr. Pratt first mentioned the wide field that his subject covered, and stated his intention of concentrating principally on "man-made interference." Members were led through the procedure in a typical case. The complaint being received, it is followed by a call to check the complainant's receiver. A simple aerial shorting test is made, the speaker pointing out that it is extremely rare for interference to enter a receiver directly via the "mains."

Comments on so-called "line filters" followed this statement. The noise itself gives a good indication to an experienced man of the cause of the interference. Then, if necessary, the radio inspector's car, complete with equipment, is called into service. Difficulties and traps in the use of this equipment were then mentioned and illustrated with the aid of "slides."

At this stage, power interference was referred to, and it was pointed out that in using a loop, maximum signal occurs with the plane of the loop parallel to the conductor. Sensing could help and a minimum obtained by travelling parallel to the conductor could indicate the source of interference. However, a further slide indicated that completely misleading results could be obtained if "standing waves" of interference existed. Intensity measurements might give a clue, but, again, maximum intensity might occur, a matter of miles from the actual source.

In fact, no single method of location of the source

of interference existed. A combination of all available methods frequently had to be used, the final outcome depending, even then, on the experience of the inspector concerned. Examples of actual cases were given by Mr. Pratt, perhaps the most interesting being what has become known as the Amberley case.

Aeradio Harewood reported heavy interference on 333 kc. Minor faults in the power circuits within the vicinity were located and the power board concerned closed down the area to carry out the requested maintenance. Harewood reported the interference as still existing and obtained a bearing passing through Amberley. Meanwhile, heavy interference had been reported from the Amberley area, and investigation located it as arising in an aluminium-copper junction in an 11,000-volt cable in this area. This was put in order, and the interference at Harewood, 30 miles away, ceased at the time of the shut-down in the Amberley area.

Mr. Pratt advanced the theory that some circuit in this area was resonant at 333 kc. This and other examples served to show the difficulty of the problems with which the radio inspector had to deal.

The meeting closed at 9.30 p.m. after a vote of thanks had been proposed by Mr. Gregory.

DUNEDIN

On Thursday, 14th July last, Dunedin Branch members had the privilege of viewing a series of films. These included a number of subjects, the most interesting being a film dealing with the uses of radar at sea. This film, dealing with the Metro-Vickers "Seascan," gave a wonderful demonstration of the increased safety at sea conferred on ships having this apparatus installed.

At the conclusion of the screenings, supper was served and an enjoyable meeting came to a close.

WELLINGTON

A questionnaire has been issued by the Wellington Branch to its members with a view to ascertaining their ideas on local activities.

Members would assist their committee by promptly completing the questionnaire and forwarding it to the Hon. Secretary, Mr. J. D. McCormick, 17 Aglionby Street, Lower Hutt.

The Wellington Branch has had many successful meetings and has heard many interesting lectures. The July meeting had the pleasure of an address by Mr. G. J. Wood, of the Meteorological Office, entitled "Electronics as Applied to Radiosonde." This address was particularly successful, and members showed much interest in examining the equipment produced by the lecturer; New Zealand as well as English and Japanese equipment was discussed and examined.

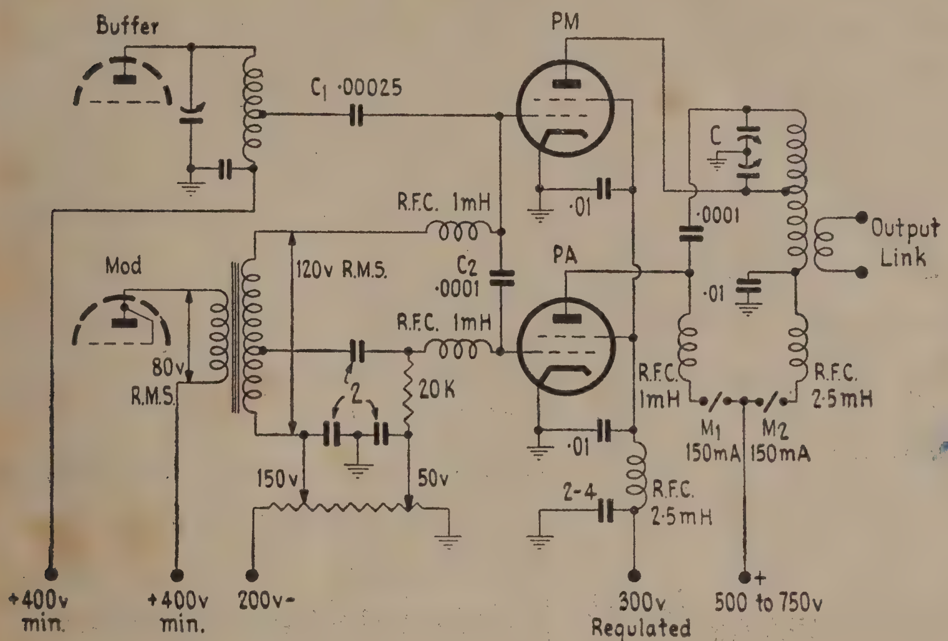
The August lecture by Mr. R. E. Grainger, an Associate Member of the Institute, entitled "Disc Recording," gave members an insight into the problems of making and mass-producing records, and described today's methods of recording and reproducing sound. This, also, was a very interesting address.

Members are reminded that their subscriptions are now due and payable to Mr. D. L. Rushworth, 20 Birch Street, Waterloo, Lower Hutt.

The Taylor Super-Modulation Principle

INTRODUCTION

In a recent issue of our American contemporary, "Radio News," is an article by R. E. Taylor describing a new system of modulation in the production of transmitters, and also on the amateur bands in his own station. It is a low-level modulation system, and uses only 8 watts of audio frequency power for a transmitter rated at a kilowatt. It therefore has obvious advantages apart from its technical ones, and these, if the inventor's claims—and others observations—are to be relied upon, are many. The purpose of this article is not to argue the pros and cons of the Taylor super-modulation system, as it has been named, but to report to our readers what the claims are. The following list is taken from the original article in "Radio News," and, while we do not at this stage entirely agree with all of them, here they are for what they are worth. By this, we do not mean that in our view the claims are unfounded. Far from it, but certain of them do not at first sight appear to be exclusively the possessions of the Taylor system, as the original article might appear to maintain. But more of that at a later date.



Taylor Modulation Circuit, as modified and used by two Wellington amateurs,—ZL2DQ and ZL2WS.

THE INVENTOR'S CLAIMS

This modulation system (states the article) has the following advantages:—

(1) Shows considerable reduction in BCI. Many cases of BCI have been cured by the use of super-modulation, because of lack of "buckshot" and splatter.

(2) Provides more than double the overall operating efficiency of conventional systems with far less complicated tuning and adjustment.

(3) The audio power in the 1 kw. amateur transmitter is only about 8 watts.

(4) Provides far greater plate efficiency than conventional practice.

(5) The power amplifier and positive modulation tubes, being audio-pulsed for modulation, allow greater power input and output. This feature is not new to the radar people, as plate dissipation over a period of time for power output can be engineered and used to advantage.

(6) More db. of talk-power per size and weight, as well as more power input than any other conventional system is offered.

(7) About the same power distribution capabilities under full modulation, with respect to sideband power and carrier, as wide-band FM with 30 kc/sec. total deviation for 15 kc/sec. audio frequency response.

(8) Provides a substantial effect in reducing the noise-level of a conventional receiver for this type of operation.

WHAT IT IS

What, then, is the scheme that is used to bring about these numerous advantages? Through a somewhat unfortunate use of the term "pulse" in Taylor's original article, there appears to have arisen a good deal of misapprehension and a tendency to describe the system as pulse-modulation. In actual fact, the system bears little or no relation to what is normally defined as pulse-modulation, and any talk of pulses

really refers only to the fact that one of the valves in the power amplifier stage produces its greatest output only during the positive peaks of the audio modulation signal. The Taylor system is best described as a newly developed type of controlled-carrier system, in which a high-efficiency-grid-modulated final amplifier is used. The scheme thus combined some of the best features of the quite old controlled-carrier system with those of the relatively much more complex high-efficiency grid-modulated amplifiers developed by Dome, and by Terman and Woodyard.

HOW IT WORKS

The circuit herewith is almost identical with one given in the "Radio News" article by Taylor, except that values are inserted which make it suitable for two 807's, as against the 4-250A's shown by Taylor. This circuit is one which has actually been built and got working by ZL2DQ and ZL2WS, and so will hold considerable interest for those amateurs who wish to try it out with the least possible delay.

The scheme of its operation is briefly as follows. The valve PA is biased and excited in such a way that it gives a carrier output consistent with its full ratings. Thus, under no-modulation conditions, PA produces an unmodulated carrier. The tube PM is excited from the same valve as is PA, but is biased much farther back, as can be seen from the bias circuit. As a result, it gives practically no output at all under conditions of no modulation. In practice, in the circuit shown, it draws only about 10 ma. with no modulation applied to the transmitter. However, when the audio signal is applied to the grid-bias modulator tube, the grids of both PA and PM receive modulation signal. The differences in their behaviour under modulation are accounted for solely by their different biasing, and different values of excitation, both radio and audio frequency. The valve PM, it will be noticed, receives considerably more audio excitation than the tube PA. On account of the former's high negative bias, this results in PM delivering output during the POSITIVE HALF-CYCLES ONLY of the audio cycle. In other words, it is only during the positive audio half-cycles that the R.F. driving voltage extends far enough into the positive-grid region for PM to produce a great deal of the R.F. output. When this occurs, the tube PM draws much more power from the exciting valve, and the feed to PA and PM is so arranged that the excitation to tube PA drops to a low value. Thus, on the positive modulation peaks, practically all the output power is supplied by PM, and very little by PA. It can be seen, therefore, that, during the positive modulation peaks, the situation with regard to the relative power outputs of the two valves is reversed compared with no-modulation conditions.

On the negative modulation half-cycles, the bias on tube PM is so high that this valve produces no output at all. CONDITIONS DURING THIS PERIOD ARE THEN EXACTLY THE SAME AS IF THE VALVE PM DID NOT EXIST. In other words, the tube PA is working as a completely conventional plate-modulated amplifier during the negative modulation half-cycle. Taylor, in his original article, refers to the carrier produced by PA under no-modulation conditions as the "negative peak cushion." This is a very good name, as it indicated just what PA is called upon to do during the negative half-cycle of the modulation waveform. In short, it prevents the R.F. output from hitting zero except at the extreme negative peak. If PA does not produce enough R.F. output in the unmodulated state, then the R.F. output will become cut off before the modulation cycle reaches its negative peak, and so there will be an appreciable time during which there is no R.F. output. This is exactly the condition in a conventional transmitter which is doing what is commonly known as "negative peak clipping."

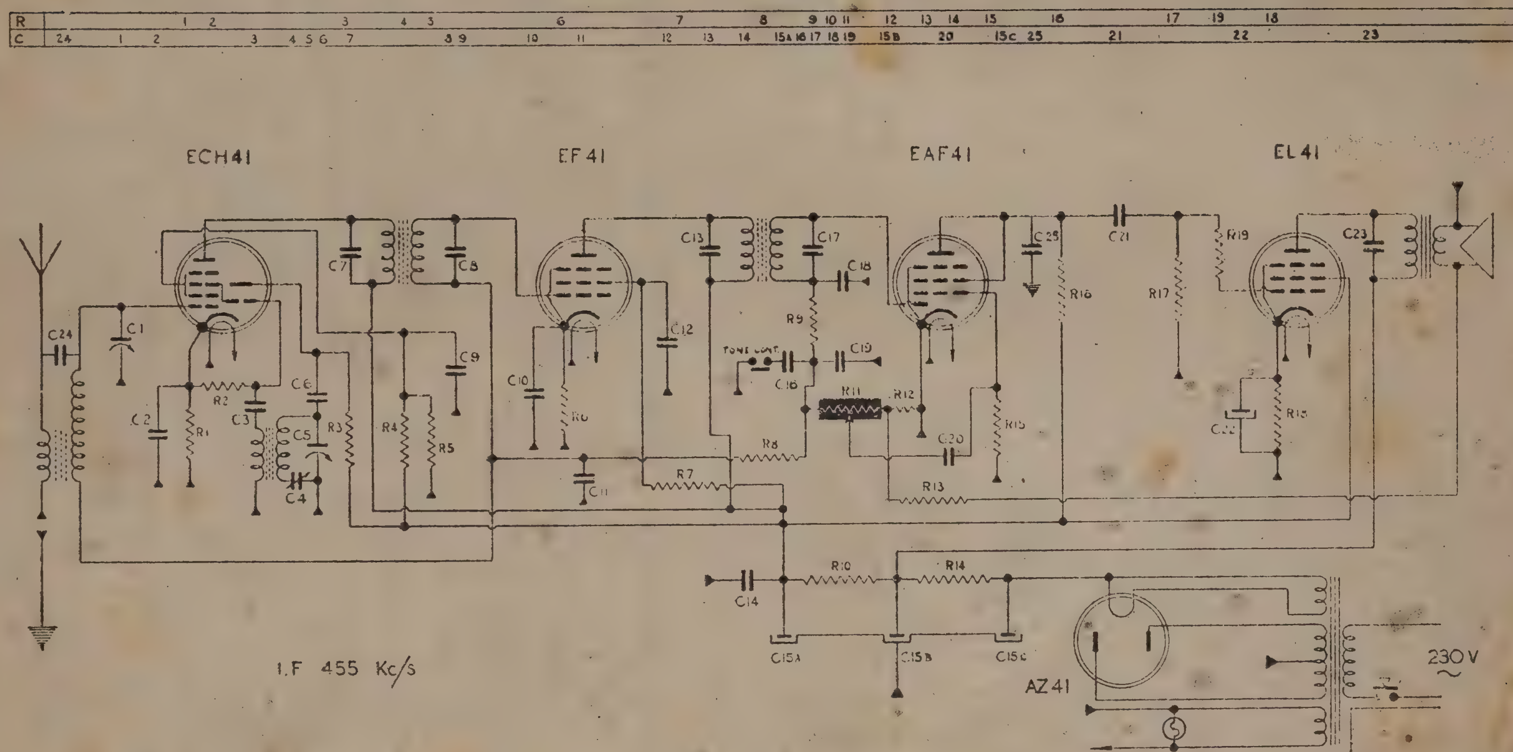
Where, then, does the "reduced carrier" effect come from? Simply this, that the R.F. output of the tube PM during the positive modulation half-cycles is much greater than necessary to supply a peak R.F. output voltage of twice the carrier voltage given by PA under no-modulation. Because of this, the envelope of the modulated R.F. output has a far greater peak-to-peak amplitude than corresponds with a carrier of the level produced by PA; expressed in another way, a carrier of much greater amplitude than the one actually given out by PA would be necessary in a **conventional** modulated amplifier stage if the peak-to-peak amplitude of the modulated wave were to equal that given by the Taylor system.

The above explains why the effect in a receiver, when a transmitter like this is being heard, is that of a very weak carrier, upon which an exceptionally heavy modulation appears as soon as the operator speaks. It also explains why a Taylor-modulated system is much less subject to heterodyne interference.

FOR THE SERVICEMAN

THIS MONTH'S CIRCUIT FEATURES THE PHILIPS RADIOPLAYER MODEL 209. THE I.F. FOR THIS SET IS 455 kc/sec.

PHILIPS MODEL 209



C1 Tuning condenser
C2 .047 mfd. 400v. paper
C3 47 mmfd. ceramic
C4 150-750 mmfd. padder
C5 Tuning condenser
C6 200 mmfd. mica.
C7 I.F. trimmer
C8 I.F. trimmer
C9 .01 mfd. 400v. paper
C10 .047 mfd. 400v. paper
C11 .047 mfd. 400v. paper
C12 .01 mfd. 400v. paper
C13 I.F. trimmer
C14 .25 mfd. 400v. paper
C15A 40 mfd. 400v. electrolytic
C15B 40 mfd. 400v. electrolytic
C15C 20 mfd. 400v. electrolytic
C16 1500 mmfd. mica
C17 I.F. trimmer
C18 100 mmfd. ceramic
C19 100 mmfd. ceramic
C20 .01 mfd. 400v. paper
C21 .01 mfd. 400v. paper
C22 25 mfd. 25v. electrolytic
C23 4000 mmfd. mica
C24 10 mmfd. ceramic
C25 250 mmfd. mica
R1 180 ohm ½ watt
R2 22K ½ watt
R3 25K ½ watt
R4 30K ½ watt
R5 47K ½ watt
R6 600 ohm ½ watt
R7 100K ½ watt
R8 2,2M ½ watt
R9 56K ½ watt
R10 1500 wire wound 3W
R11 .5 meg volume contrl.
R12 47 ohm ½ watt
R13 180 ohm ½ watt
R14 150 ohm 3 watt wire wound
R15 5.6M ½ watt
R16 150K ½ watt
R17 470K ½ watt
R18 150 ohm 1 watt
R19 22K ½ watt

A SIMPLE VOLUME-INDICATOR

(Continued from page 10.)

best plan is to take off the original meter scale and substitute for it a plain one with a red mark at the position of 0.7 of full-scale deflection. Then, when the meter is in use, we will not be distracted by a complete scale that we are not using. The purpose of using 0.7 of full scale as the reference level and not full scale itself is that, in an indicator of this sort, there is always a slight amount of over-shoot. That is to say, the weight of the meter's pointer sometimes carries it past the place on the scale where it would have come to rest had the audio peak that made it move rapidly continued as a steady tone. Thus, the actual level is a little less when over-shoot occurs than the meter reading indicates. This is not a serious disadvantage unless the over-shoot is particularly bad, but the average meter will not give much trouble in this respect. Meter movements that are used in commercial equipment for this purpose are of special mechanical and electrical design, and are constructed so that, while extremely rapid movement of the pointer takes place as long as current flows through the coil, the movement ceases abruptly as soon as the current ceases to flow. A meter of this type is fast to respond to audio peaks, but does not give a false indication through over-shooting. One way of damping the meter so that the over-shoot is only slight is to shunt it. Thus, if a 0-500 μa. movement is used and shunted so that it reads 0-1 ma. or more, the movement is damped electrically. However, the over-shoot of the small surplus 0-500 amp. meters mentioned above is very slight without any additional damping, and these meters can be used quite successfully as they are.

OTHER CIRCUIT ARRANGEMENTS

If there is room on the chassis for one extra valve, but not for two, it is possible to use a double triode, such as a 6SN7. In so doing, one section of the valve is connected as a diode by strapping the grid to the plate at the socket. Apart from this, the identical circuit can be used. The bias resistor for one-half of a 6SN7 is close enough to that for a 6C5 for the difference to be ignored in this application.

It is also possible to use a double-diode-triode in a similar circuit. The question here is mainly one of the suitability of the triode section. That of a 6Q7 is not very suitable, owing to its high amplification factor, but the 6R7 is very suitable, if one of these fairly uncommon tubes happens to be on hand. The only real difference in the circuit, when a D.D.T valve is to be used is that the cathode of the two valves is common, which makes it necessary to return the meter's positive terminal to the cathode instead of to earth. This puts the whole meter a few volts above earth as far as D.C. potential is concerned, but this does not matter at all, and the operation of the circuit will be found identical in all respects to that of the original two-tube one.

ROLA "ANISOTROPIC" SPEAKERS WILL "SPEAK" FOR THEMSELVES.

A POPULAR FIGURE RETIRES

Announcement this month of the retirement of Norman Swann from the business he founded and developed prompts reminiscence of one of the industry's leading personalities.

Norman Swann has done a lot for the electrical trade in this country and abroad. For as long as he can remember, Norman has been in the radio and electrical business. Born in Melbourne, and educated at Scotch College there, he joined up with Noyes Brothers as country radio traveller away back in 1925, when the industry was in its infancy. After six years of helping this lusty young newcomer to establish himself as a force in life, he resigned from Noyes and spent eight months on a trip round the world.

A meeting in Chicago with Charles Forrest, of International Radio, bore fruit when Norman returned to Melbourne and joined the newly-opened Melbourne branch as salesman. A year later he was Melbourne manager, and for the next five years—those hard years of the early and middle thirties—Norman developed International's growing Melbourne business.

In the meantime he had married a Melbourne girl and brought her across to New Zealand with him in 1937, when he decided to shift across here and start in business on his own account.

That was the start of the Swan Electric Co., Ltd. With financial assistance from the Australia Rola Co. and the then Aerovox Co. of Melbourne, Norman opened a small office in Auckland. He had the agencies for Rola speakers, Aerovox condensers, and Utah vibrators. After a difficult period for the first year, the business started to expand, and in 1938 Dave Reid joined the staff.

Came that momentous morning in 1938, when import control was announced, and Swan Electric—as well as many other importers—wondered what was going to become of them. Norman didn't wonder for long; he made a quick trip to Melbourne and proposed to the Rola Co. that a factory should be established in New Zealand for the manufacture of Rola speakers. Premises were obtained in Hope Gibbons's building, Wellington, and the factory went into operation in 1940.

By 1941, domestic radio production had ceased, and the whole industry was engaged on war contracts. Swan Electric turned out trench-mortar fuses at the rate of 7000 a day, several hundred thousand transformers at 400 a day, and in the latter stages of the war all the speakers for amenity receivers

By the time the war finished, the young company was operating in Auckland and Wellington, and had opened a branch in Christchurch, under the direction of Ken Schollum. Other parts of the industry had grown, too, and there was a manufacturing capacity in this country several times greater than pre-war. Fortunately, large stocks of material suitable for domestic radio were held by the Radio Controller's Office and others, which allowed for a quick swing to domestic production. The bottleneck was loudspeakers. As radio manufacturers throughout the world had switched their production to munitions work, the capacity was quite inadequate to fill the demand. With tremendous effort Swan's speaker production was built up to approximately 500 a day, and it is now generally accepted that the industry would

have been in a serious plight had it not been for the Swan Electric Co. The company received requests to supply speakers to Australia, South Africa, and the U.S.A., but local demand more than took up the whole of the factory's production.

In the meantime, the importing business was also expanding rapidly until Swan Electric grew to be the acknowledged largest supplier of all radio equipment to the industry. In a trip to England and America in 1944, Norman had negotiated sole agencies for some of the best-known radio components manufactured in both countries, and as a result the company's business expanded greatly. A further trip round the world in 1946 consolidated old friendships and introduced further valuable agencies. A branch was opened in Dunedin under Norman Chiswell, who had already given valuable service in the Auckland and Wellington offices.

Swan Electric has been progressive in outlook and policy since the day it started. The factory has taken on, in addition to its standard lines, the manufacture of the world's smallest midget I.F. transformer, about the size of a thimble, an excellent line filter, and lately the manufacture of fluorescent ballasts of all types. The overseas agencies have produced firm friendships, not only for Norman personally, but also for his company and for the men who have helped him build it.

Norman Swann can step down with a feeling of satisfaction in having accomplished something worth while. If he should choose to leave us and return to his native land, our paper and his many good friends in the trade here and abroad will wish him well wherever he goes and hope to see him again.

TRADE WINDS

Addressing Auckland Rotarians recently, Mr. D. T. Clifton-Lewis, of Radio (1936), Ltd., commented that, in New Zealand, television is still very much an achievement for the future. Though Australia has been working on television for the past two years, indications are that there will be a further lapse of at least two years before any sort of service is inaugurated. Reports that television in New Zealand is just round the corner should not be believed, said Mr. Lewis, pointing out that, as we in New Zealand have not yet started on the project, it will be five years at least before television comes to our country, and even then sets and fees will be extremely expensive.

* * *

PHOTO FLASHLIGHT DEVELOPMENT

Credit goes to a Hutt Valley photographic firm (Sexton & Bowden) for the development of a flashlight unit capable of producing a minimum of 1500 flashes, dry battery operated. Weighing only 10 lb., including batteries, the equipment can be produced and sold in New Zealand more cheaply than the nearest equivalent imported article. An application for a patent for the circuit system has been filed, and it is understood that a large New Zealand photographic firm is interested in the selling rights.

* * *

MORE MOBILE RADIO SERVICES

Latest services to install mobile radio equipment are the Hutt Valley Fire Board and the Hutt Valley Traffic Offices. Soon a Petone taxi company will be linked also as sets become available, the service for which will be operated on a different frequency from that used by Wellington taxis.

* * *

LISTENERS' LICENCES

Details furnished to "Radio and Electronics" by the Wellington Radio Traders' Association show that there are more than 430,000 radio listeners licensed in New Zealand. The latest figures released by the Post and Telegraph Department are as follows:—

NUMBER OF RADIO LICENCES IN FORCE AS AT 31st MARCH, 1949

District	Receiving Licences					Private Experimental	
	Receivers	Dealers	Mult.	Spec.	Free	Amtr.	Res.
Auckland ..	148,018	619	15	1	724	602	4
Canterbury	75,045	309	28	1	340	296	—
Otago ..	57,349	231	13	—	240	216	2
Wellington ..	149,726	600	27	1	647	714	5
Totals ..	430,138	1,759	83	3	1,951	1,828	11

Grand Total: 435,773.

Totals as at 30/9/48	428,517	1,749	83	3	1,887	1,715	11

Grand Total as at 30th September, 1948, 433,965.

* * *

Included in the latest shipment of miniature tubes received by S.T.C. are new types 6T8, 19T8, 8D3, and R10.

* * *

Latest among the productions of General Electric (U.S.A.) is a neon glow lamp with a life of 25,000 hours, for use in domestic appliances, switchboards, etc.

* * *

Electronic and General Industries, Ltd., Wellington, agents for "Envoy" photographic products, advise that their principals are now manufacturing a wide angle plate film camera designed to meet the exacting needs of the architect and commercial photographer.

WELLINGTON RADIO TRADERS' ASSOCIATION

The presidential report delivered at the annual general meeting of the Wellington Radio Traders' Association, held on 17th August, revealed that the trend towards competitive receiver-selling is now apparent, some firms even resorting to "premium" methods. The report went on to state that, generally speaking, there has been increased production in a number of models, notably portables and auto radios. To those dealing with imported commodities, however, the return of the rate of exchange to parity has caused real problems, and in order to preserve present returns sales will have to be increased.

Undoubtedly this will have the effect of keener competition. Membership of the Association is still increasing. The election of officers for the ensuing year resulted as follows: President, Mr. D. B. Billing; executive, Messrs. I. R. Cosgrove, W. Young, P. B. Billing, and J. Hallett; secretary-treasurer, officer of the New Zealand Employers' Federation, auditor, Messrs. G. Y. Berry and Miller.

* * *

The Auckland Radio Traders' Association held its annual general meeting on 23rd August, but at the time of going to press no details of its deliberations have come to hand.

* * *

CLASSIFIED ADVERTISEMENTS

Rates are 3d. a word, with a minimum charge of 2s. Advertisements must be to hand in this office not later than the tenth day of the month in order to be published in the issue appearing at the beginning of the following month.

While all care will be taken, no responsibility can be accepted for errors. Advertisements should therefore be submitted either typed or printed in block letters.

PHILIPS EXPERIMENTER

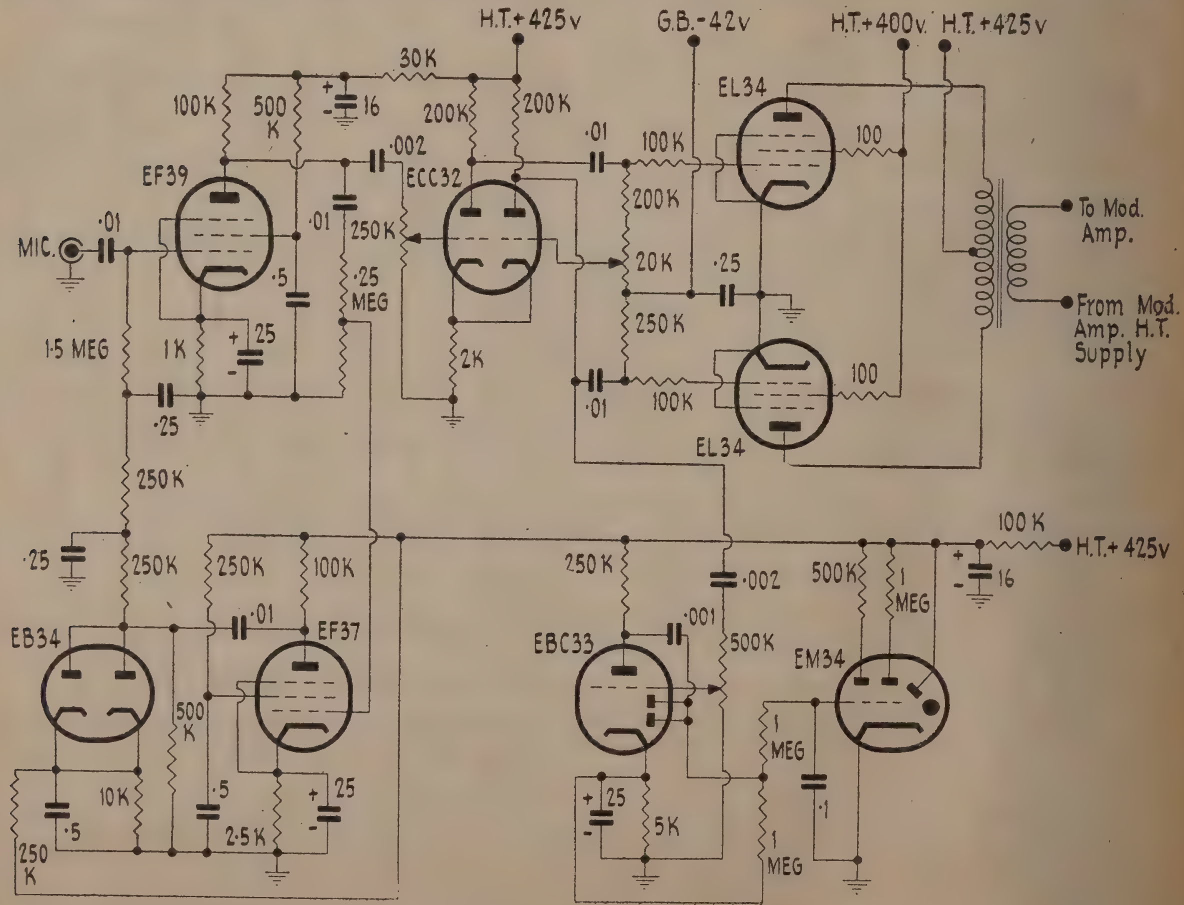
(Continued from page 35.)

unusual, but are neither difficult to supply nor costly, in relation to the power delivered by the modulator. The plate and screen currents of the EL34's are:

Ip		Isg	
Zero Sig.	Max. Sig.	Zero Sig.	Max. Sig.
40 ma.	212 ma.	4.8 ma.	56 ma.

These currents are for a common plate and screen voltage supply of 425 volts, with the screens fed through a common dropping resistor of 800 ohms. Now a single power supply for both plates and screens would need to supply a maximum current of 268 ma. This would necessitate a specially made power transformer, since, although the voltage is comparatively low, the maximum current is higher than any stock power supply transformers will supply. Also, the total current swing would be from 44.8 ma. at no signal to 268 ma. at maximum signal, and this would necessitate a supply with excellent regulation. However, there is a way out of this difficulty, and it consists in using separate power supplies for plates and screens of the modulators. This solution will undoubtedly be cheaper than having a single special transformer made to order, because a 500-volt-a-side transformer, rated at 200 ma. continuous output will be quite satisfactory for the plate supply, and this is a standard line with at least one manufacturer. For the screen supply, an 80 ma. transformer will do very well, as it will have approximately 24 ma. up its sleeve for supplying a bleeder resistor. A further advantage of this scheme is that good regulation in the plate supply can be obtained from a properly designed filter using a swinging choke and gas-filled rectifiers, while adequate regulation for the screens can be got simply by using a bleeder across the screen power supply. This is clearly a practical proposition, as we can see by examining the operating conditions laid down for common supply. The 800-ohm screen dropping resistor specified will have a voltage drop of 44.8 volts at maximum signal, so that the screen voltage regulation must be slightly worse than 10 per cent.

This gives us a clue as to what order of screen voltage regulation we can tolerate when using a separate supply, as it is safe to assume that as long as this supply has a regulation that is as good as or better than that realized when a dropping resistor is used, then there will be no loss of power output due to screen regulation. In most cases where large pentodes and/or beam tetrodes fail to give the output power expected of them, the trouble can be traced to poor screen voltage regulation, so that if we keep



within the recommended value of, say, 10 per cent., we will have no trouble from this cause. In fact, it is to be expected that the use of a separate screen voltage supply, which can easily have better regulation than the maximum allowable 10 per cent., will give us a slight but useful reserve of output power, over and above the 8 watts that we already have in reserve to allow for losses in the modulation transformer. Incidentally, the latter are frequently ignored by amateurs when designing a modulator stage, with the result that the desired output power is not obtained actually at the transformer secondary, where it is wanted, even though measurements may reveal that the valves are supplying their rated power output to the transformer primary. In our case we want an actual 50 watts at the secondary of the modulation transformer, and, since the modulators are rated to give 58 watts at the conditions under which we intend to work them, a short calculation will show that the modulation transformer must have an efficiency of 85 per cent. or better if we are to have 50 watts of **useful** power output. This figure should be readily obtained in a transformer of this size.

ONE DIFFICULTY

The use of separate plate and screen supplies introduces one slight difficulty, in that arrangements must be made for plate and screen voltages to be applied simultaneously, for fear of damage to the modulator valves. This can easily be arranged for at little cost by initiating a time-delay circuit by the swiching on of the two supplies and arranging that, after voltage is available from the supplies, both are simultaneously applied to the modulators by the time-delay relay. An arrangement of this sort will be described when we come to show how complete power supplies and a proper interlocking protective system can be constructed for this (or any other) transmitter. In addition, arrangements will be made to protect the modulation transformer from flash-overs by allowing H.T. from both supplies to be applied only after the modulated amplifier has been switched on. Because of the addition of the protective circuitry to the power supplies, we are not placing the modulator's supplies on the same chassis as the audio circuit. This has the advantage of eliminating much cabling of leads between the various panels of the transmitter and also of keeping the low-level audio stages away from the power supplies' magnetic hum-fields.

OUR GOSSIP COLUMN

That inimitable broadcasting celebrity, Aunt Daisy, poses for H.M.V., complete with "Nipper," the famous mascot. Apparently "Nipper" is doing his best to concentrate on both the radio and hints on cooking.

For the purpose of entering business as an electrical wholesaler at 242 Durham Street, Christchurch, Mr. J. M. O. (Mick) Walker, popularly known throughout the radio industry, has severed his connection with the National Electrical and Engineering Co. after 25 years' service.

Jack Cunningham, a well-known radio enthusiast in the South Island, has been appointed in Mick's place as manager of the N.E.E. Co. Christchurch branch.

Our best wishes go to Mick Walker for every success in his new venture, and our congratulations to Jack Cunningham on his promotion.

* * *

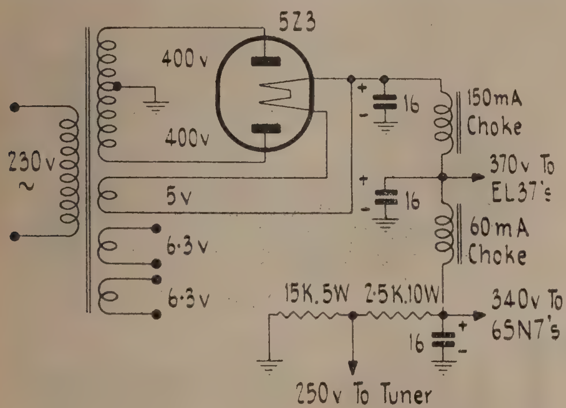
Visitors to "Radio and Electronics" offices in Wellington recently have included Les Hepburn, of Tricity House, Christchurch, Noel Laird, of J. & C. Laird, Ltd., Hawera, Jim Eckford, of S.O.S. Radio, Ltd., Auckland, and Lindsay Grey.

AMPLI-TUNER

watts, but that at the higher frequencies the output is shown as lower than this. This is a better method of testing than that of keeping the power output constant and measuring the distortion, irrespective of what the 'scope pattern looks like, because it tells more about the amplifier, and also it seems silly to measure the distortion of an amplifier when the 'scope shows that it is obviously overloaded.

Frequency	Maximum output.	Distortion percentage.
1,000 c/sec.	10 watts	0.35 per cent.
5,000 c/sec.	—	
10,000 c/sec.	—	1.0 per cent.
15,000 c/sec.	—	0.6 per cent.
50 c/sec.	—	0.6 per cent.

These figures show that the distortion is very low at all frequencies, and bring out one very important fact—namely that the falling-off with frequency of the undistorted power output is very slow. Many amplifiers which show up quite well on a simple frequency response curve fail to give good results on a test like the one above. For instance, an amplifier which will deliver 10 watts at 1000 c/sec. will often



be found to give only 2 or 3 watts at 10,000 c/sec. Behaviour of this nature indicates that quite large degrees of intermodulation distortion will be present at high output levels. The situation is eased somewhat by reason of the fact that an amplifier is not often called upon to deliver its full output at very high audio frequencies. For this reason, the figures obtained for this amplifier are entirely adequate for high-fidelity reproduction, in spite of the slight falling-off of undistorted output at the high-frequency end of the scale.

The quality of the results given by the whole system, from the aerial terminal to the output of the amplifier, was also checked by using a modulated signal generator and taking further distortion measurements. When a radio receiver as a whole is tested for distortion, it is always found that the most difficult conditions are those of high modulation percentages at high audio frequencies. Similar remarks apply to the performance of radio transmitters also, and to modulated signal generators, too. It was found that, with a modulation frequency of 10,000 c/sec. and a modulation percentage of 85 per cent., the overall distortion at full amplifier output was only 3 per cent. When it is considered that a similar figure for the average radio receiver is often more of the order of 30 per cent., it will be realized that the performance of this outfit as a radio receiver is very good indeed, and it will be found to bear comparison with any receiver that is labelled "high-fidelity."

CONSTRUCTION

The photographs on the front cover of this issue and on these pages give a very good idea of the layout and construction of the unit. The chassis is quite large, but not particularly so when all that is on it is taken into account. It will not be difficult to place the various valves on the cover picture when it is realized that the three 6SN7's run up the right-hand side of the chassis, and that the tuner occupies the front centre portion of the chassis. The power transformer is in the left-hand back corner. Next to it is the 5Z3 rectifier, and to the right again are the output transformer and the EL37 output valves. In front of the power transformer are the first two filter condensers, and in front of them again is the main smoothing choke. The control shaft at the left of the chassis is that of the rotary on/off switch, while the position of the volume control potentiometer, close to the amplifier input, can be seen also. The push-button unit is centrally placed on the front of the chassis, and underneath the row of buttons can be seen the mounting screws and the 10 adjusting-screw holes of the dual I.F. trimmers that are used as tuning condensers.

These can also be clearly seen in the under-chassis view, together with the paralleled mica condensers wired in to bring the aerial tuning capacity up high enough for the low-frequency buttons. In the underneath view, the amplifier valves and their components can be seen along the left-hand side of

the chassis, with the EL37 sockets a little to the right, near to the aerial terminal, which is on the back of the chassis. Approximately in the centre of the chassis is the 60 ma. smoothing choke, behind the wiring of the tuner section. The aerial coil is seen almost in the centre of the chassis, just behind the push-button mechanism. The oscillator coil is somewhat obscured in the photograph, but is actually the almost black patch at the right-hand end of the push-button unit. The voltage divider was made up in our case from five 5000-ohm resistors of 10 watts rating each, and these can be seen at the right-hand end of the chassis, mounted on the side by means of insulated terminal strip. The above description covers most of the major components, and constructors should have no difficulty in producing a reasonably accurate physical copy of the original.

There is only one point that has not perhaps been sufficiently stressed, and that is the arrangement of the amplifier's negative feedback link. The speaker plug is at the back of the chassis, and attached to two of its connecting lugs can be seen the feedback resistor, R25. The other resistor of the feedback voltage divider, R26, is mounted right at the socket of V1, so that the lead between R5 and R 26 is very short. Thus, the long lead that has to be run from the output to the input of the amplifier is at an impedance of only 50 ohms, and can be taken across the chassis by the most direct route, unshielded, without trouble from undesired capacitative pick-up.

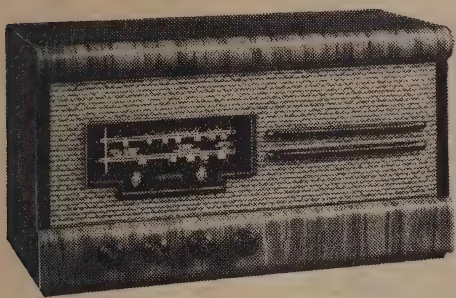
CONCLUSION

In view of the excellent performance, both of the amplifier itself and of the "ampli-tuner" as a whole,

(Continued on page 48.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

COURTENAY MODEL 27 "GRENVILLE"
(Turnbull & Jones, Ltd.)



THE GROVER "TWO-IN-ONE" TAPON
(Grover Electrical Co., Ltd.)

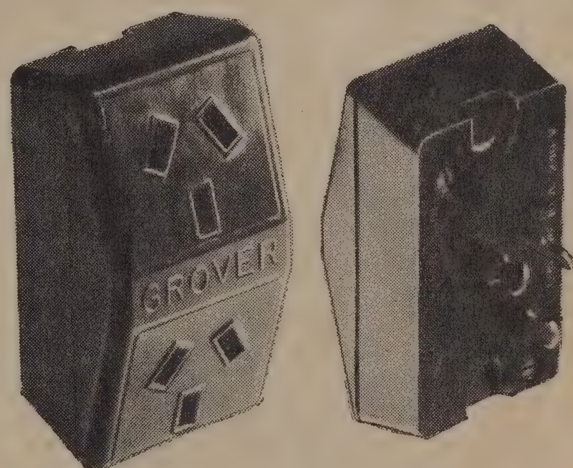
The latest release in the Courtenay range is the Model 27 "Grenville," illustrated. This set is notable for its very high sensitivity on both broadcast and shortwave bands. Broadcast coverage is 550 to 1600 kc/s., and the shortwave band makes use of the bandspread principle covering the 19, 25, and 31-metre bands over the frequency range 9.4 to 15.6 mc/s.

The tuning on shortwave is delightfully easy, and the arrangement is such that the scale length is apparently three times greater than normal.

The valve arrangement is: 6K8 converter, 6K7 I.F. amplifier, 6Q7 detector audio amplifier A.V.C., 6V6 output, 6X5 rectifier; speaker is 8 in. E.M.

Sensitivity over broadcast band approximately 10 microvolts and over shortwave band approximately 15 microvolts for standard 50 m/w. output.

Other features include the so-called "floating grid" audio amplifier, grid circuit tone control, A.C. power switch, and large bold-lettered edge-lit dial scale. Only recently released, sales of this model to date exceed supplies.



A double tapon without wires is this latest Grover appliance accessory. Produced as a complete unit it dispenses with separate three-pin plug and cord lead. Makes for neat fit and finish and allows of easy plug-in of existing appliances with three-pin plugs. An added advantage is that the base is so constructed that it will fit over certain flush wall plates. The contacts, which are of heavy spring brass strip, form their own inter-connections, so that there is no internal wiring at all between corresponding contacts on the two outlets. The pins of the plug are secured firmly to the inter-connecting brass strips, virtually eliminating the possibility of high-resistance contacts inside the heavy bakelite case.

The moulded bakelite case is sturdy and well finished, giving the unit a neatness of appearance not generally found in two-way connectors of this nature.

Rated for total loading 10 amps 240 volts. Overall dimensions approximately 3 in. long by $1\frac{1}{2}$ in. wide by $1\frac{1}{4}$ in. deep.

A Practical Beginners' Course

PART 35: A SIMPLE SET FOR BUILDING ON A METAL CHASSIS

Last month we had something to say about the virtues of building even small sets on a metal chassis. There are other advantages, too, so that, for experimental sets, the new method of building is very much worth while, even if it takes longer to put the set together because of the metal work involved. Luckily, several circuit experiments can be mad with the one metal chassis, because most one-valve circuits, for instance, can be built with a standard chassis lay-out. Also, if the one-valve chassis is made a little larger than strictly necessary, it is a simple matter to cut one or more holes for further valve sockets, thus making the same chassis do for two or even three-valve circuits after one has thoroughly explored the possibilities of the one-valve circuit.

The set we are about to describe makes use, for the first time in the course, of an indirectly-heated, or cathode-type, valve. This will be found a great advantage, in spite of the extra expense involved in purchasing a filament transformer. Of course, one can use batteries to heat the valve, but dry batteries, such as can be made up from No. 6 cells, will not last very long when used to heat a valve whose heater current is 0.3 amps. Also, a small filament transformer will be found a very useful adjunct to the experimenter's stock of parts.

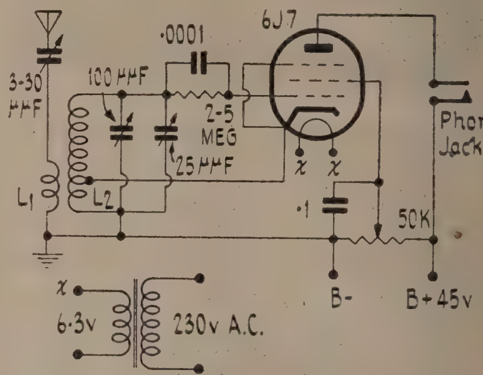
THE CIRCUIT

This circuit serves as an admirable introduction to the use of heater-cathode valves, as it is one that cannot easily be used, without amendment, for a set which is to employ a directly-heated valve.

The reason for this is to be found in the way in which the cathode of the valve is connected. The set is a regenerative detector, no different in principle from those that we have already built for use on broadcast stations, but which is rather different in detail. Practically all the regenerative circuits that we have seen so far have used a tickler winding in the plate circuit, to feed R.F. back from the output to the input, and give the great increase of sensitivity that regeneration brings. We remember that all the regenerative circuits so far built have been capable of oscillating, or generating radio frequencies themselves, and that this oscillation is used in working the set, to enable us to spot the presence of very weak stations. To do this, the regeneration control is set so that a slight rushing sound is heard in the phones, indicating that the detector is oscillating, after which each signal that appears as the set is tuned shows up as an easily heard whistle. Then, to tune the station in properly, the regeneration control is backed off until the set is just not oscillating (its most sensitive condition), whereupon the signal is heard without the whistle.

The upshot of this style of operation is that any regenerative set has to be able to oscillate. If it does not, it is not possible to set it to the very sensitive nearly-oscillating condition. Because of this, every regenerative set has a detector circuit that is basically an oscillator circuit. It is just the same as a circuit which is designed to oscillate all the time so as to act as a generator of R.F. The only differences between the detector and an oscillator is that the former must have some means of making it oscillate or not, at will, whereas the latter must oscillate all the time, and much more strongly.

Now, the circuit with the grid winding and plate tickler is only one possible oscillator circuit, which has certain disadvantages, and is seldom used as an oscillator. It can be expected that other circuits, which make good oscillators, would also make good regenerative detectors, as long as the latter's requirements are fulfilled. The circuit of Fig. 49 is that of an excellent oscillator, which is often used as such, and which, given the appropriate circuit values, makes one of the best regenerative detector circuits. We have not used it before because it requires an



indirectly-heated valve. This is because the cathode is not connected to earth, but to a point that is tapped a little way up the grid coil. Because of this, there is a small but very necessary R.F. voltage on the cathode of the valve. In fact, it is the presence of this voltage which makes the circuit work. Now, a directly-heated valve is unfortunate in having no cathode, but only a filament, which has to heat itself, and perform the functions that are done by separate parts of an indirectly-heated valve. Thus, if we took one side of the filament of a directly-heated valve to a tap in the grid coil, and connected the A battery to the other filament terminal, and to earth, in the ordinary way, the battery would act as a short circuit to the R.F. voltage that appears across the lower few turns of the grid coil. In this case, there would no longer be any feedback between the plate and grid circuits, and the arrangement would not oscillate. There is a way out of this difficulty, but it complicates the circuit, and is not so satisfactory in any case.

How, then, does the regeneration take place in this circuit, and how is it controlled? Also, readers will have noticed that the valve is a pentode. What advantages, if any, arise from using a pentode instead of a triode for our detector?

The advantage of using a pentode is chiefly that it gives more sensitivity than a triode, and enables weaker signals to be picked up. Since this set is going to be built for shortwave listening, this is an important point, as we will want all the sensitivity we can get for those very weak shortwave signals. A second advantage is that with a pentode we can get much better control of the regeneration than

Concluded on page 48.)

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PERFORMANCE FIGURES For Types 6V6, 6F6, and 6N7, IN THE "ELECTRONIC VOLTAGE-DIVIDER" CIRCUIT

In the July, 1949, issue of "Radio and Electronics" we published a short article describing a very useful circuit which enables almost any intermediate voltage to be derived from a power supply. This "electronic voltage-divider," as it has been called, can use almost any power amplifier valve, large or small, and so we are here presenting figures showing the performance that can be expected with the above smaller valves. Figures for types 807 and 6L6 were included in the original article.

For those who may not have read the original article, we are reprinting the circuit, which is exceptionally simple, and uses a potentiometer and a fixed resistor in addition to the valve.

The current that can safely be drawn from one valve can be as high as the combined plate and screen currents when it is used as a Class A amplifier, and can therefore be obtained from the valve books. If more current is wanted than one valve can supply, then two or more can be connected in parallel, or a larger valve can be used.

Another reason for using more than one valve is that the voltage drop through a single one may be too great, so that sometimes, if the main power supply has not much more voltage output than the maximum that is wanted from the voltage-divider, it will be necessary to use two valves in parallel, even if the current required is quite low.

The previous article gave figures for the performance of the circuit when 807's or 6L6's, either single or in parallel, were used. Here, we extend the information by giving tables for the three types mentioned in the heading to this article.

In the tables for the 807 and 6L6, an unfortunate error showed the load resistance in each case as being in kilowatts. We trust that readers were able to recognize this as a mistake. In the present table the correction to "kilohms," or thousands of ohms, has been made.

VALVE TYPE 6V6

No. of valves: 1

Input voltage	500	500	500	500	500	500
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	—	350	390	440	480
Minimum	—	—	46	49	53	55
Output current in ma. at maximum output voltage	—	—	70	39	15	—

No. of valves: 1

Input voltage	400	400	400	400	400	400
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	215	265	300	350	385
Minimum	—	34	37	39	42	44
Output current in ma. at maximum output voltage	—	86	53	30	12	—

No. of valves: 1

Input voltage	300	300	300	300	300	300
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	145	195	220	260	283
Minimum	—	25	27	29	31	33
Output current in ma. at maximum output voltage	—	58	39	22	8.7	—

No. of valves: 2

Input voltage	450	450	450	450	450	450
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	—	345	385	420	445
Minimum	—	—	45	48	50	54
Output current in ma. at maximum output voltage	—	—	69	39	14	—

No. of valves: 2

Input voltage	400	400	400	400	400	400
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	265	310	340	370	395
Minimum	—	38	41	43	45	48

Output current in ma. at maximum output voltage	—	106	62	34	12	—

No. of valves: 2

Input voltage	300	300	300	300	300	300
Load resistance (kilohms)	1	2.5	5	10	30	—
Output voltage: Maximum	—	195	230	250	270	290
Minimum	—	28	29	32	33	36
Output current in ma. at maximum output voltage	—	78	46	25	9	—

VALVE TYPE 6F6

No. of valves: 1

Input voltage	450	450	450	450	450
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	230	290	330	385	425
Minimum	47	51	54	58	64
Output current in ma. at maximum output voltage	92	58	33	13	—

No. of valves: 1

Input voltage	400	400	400	400	400
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	200	250	290	340	380
Minimum	41	45	48	51	56
Output current in ma. at maximum output voltage	80	50	29	11	—

No. of valves: 1

Input voltage	300	300	300	300	300
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	135	180	220	250	280
Minimum	30	33	36	39	42
Output current in ma. at maximum output voltage	54	36	22	8.7	—

No. of valves: 2

Input voltage	450	450	450	450	450
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	—	340	380	415	440
Minimum	—	60	64	70	76
Output current in ma. at maximum output voltage	—	68	39	14	—

No. of valves: 2

Input voltage	400	400	400	400	400
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	260	300	330	365	390
Minimum	50	53	57	62	68

No. of valves: 2

Input voltage	300	300	300	300	300
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	185	225	250	270	290
Minimum	37	41	43	47	50
Output current in ma. at máximum output voltage	74	45	25	9	—

VALVE TYPE 6N7 (Sections in Parallel)

No. of valves: 1

Input voltage	400	400	400	400	400
Load resistance (kilohms)	2.5	5	10	30	—
Minimum	10	10.5	11	11.5	12
Output voltage: Maximum	92	150	210	275	345
Output current in ma. at maximum output voltage	36	30	21	9	—

No. of valves: 1

Input voltage	300	300	300	300	300
Load resistance (kilohms)	2.5	5	10	30	—
Output voltage: Maximum	64	100	140	205	260
Minimum	7.5	8	8.5	8.8	9
Output current in ma. at maximum output voltage	25.6	20	14	6.5	—

W. J. BLACKWELL
"SWANS" New CHIEF

(Continuel from page 13.)

tion, and for the past two and a half years national president of the New Zealand Radio Manufacturers' Federation, a position he still holds. It was in this capacity that he instituted the first co-operative advertising campaign for the radio industry last year, when "A Radio in Every Room" became a byword throughout the country; and the annual conference in its present very effective and enjoyable form.

Bill Blackwell's creed that the health of the radio and electrical industry as a whole is of vital importance to all its members, irrespective of the brand, name, or product they represent, will serve him well at Swan Electric. He will bring to this soundly established organization a wealth of solid, technical knowledge that covers every phase of the industry, coupled with an enviable record of achievement in manufacturing, organization, and administration. He has a personality that will take him places because its' backed by "know-how" and drive. We wish him and the Swan organization every success.

AMPLI-TUNER

(Continued from page 42)

we have no hesitation in recommending this outfit as eminently suitable for those who want the highest possible quality in order to excite a large and expensive speaker system. If one has spent £30 or more on the latter item alone, it is certainly advisable to have an amplifier and tuner that will give an electrical output of comparable quality to the acoustic quality of the speaker system, and the equipment which we have just described, while not expensive, is capable of satisfying the most exacting demands of critical listeners.

QUESTIONS AND ANSWERS

(Continued from page 15.)

on the amplifier, as long as one or two important points are not forgotten. The grid resistors of the EL37's will have to be raised, too, say, 250k. This will cause the distortion of the driver tube to increase somewhat, but not to any alarming extent. We have no comparative figures available to show how great this effect will be, but at low and medium power levels, it can be expected to be negligible. One effect that we will not be able to do anything about is that a slight loss of high-frequency response will occur when the cathode followers are removed, owing to Miller effect in the output valves becoming much more effective across the high output impedance of the new grid leaks.

The modification will not cause any serious falling-off in the performance of the amplifier, but will definitely make it rather less good than in its original form. However, the modified circuit could still be regarded as a very good amplifier.

BEGINNERS' COURSE

(Continued from page 44.)

with a triode, and with careful design the regeneration control can be made to have much less effect on the tuning of the set than we get with a triode detector. On shortwaves, this is again a most important point, because tuning is more difficult there than on the broadcast band, in any case, so that if the working of the reaction control causes a very weak signal to be detuned, we are in a fair way to losing it altogether.

The amount of feedback in this circuit is controlled by two things. First of all, the position of the tap on the grid coil has a large effect, but since we cannot go changing the coil every time we want to tune in a station, we have control over this factor only while the set is being built and adjusted for use. In order to get a smooth control over the regeneration, we make use of a property of the screen-grid and pentode valve that we have not already mentioned. It is that the screen can be used to control the amount of amplification that takes place within the valve. Thus, we have a potentiometer in the screen circuit, by means of which the voltage on this element can be controlled continuously. As in a screen-grid R.F. amplifier, the screen is connected to earth by the 0.1 μf. bypass condenser, as far as R.F. voltages are concerned, but as we have explained before, this has no effect on our ability to alter the D.C. voltage on the screen, and it is this that gives us control of the amplification, and therefore decides whether the amplification is great enough for oscillation to occur. Because the regeneration control has no direct connection with the signal circuit, the control is very smooth, and causes only a very slight detuning effect on the grid circuit. This makes the set very easy to tune, even on shortwave.

Other good points about this set are its use of two tuning condensers instead of one. Some time ago readers will remember that we described various methods of making shortwave tuning less difficult to adjust, and that if we use a small tuning condenser attached to the dial instead of a large one, a small range of frequencies is spread over the whole rotation of the dial. This is known as **bandspreading,** and the small 25 $\mu\mu$f. condenser is called the **bandspread** condenser. The purpose of the large 100 $\mu\mu$f. tuning condenser is to prevent us from having to change coils as often as if the small condenser were the only one. Thus each coil covers a frequency range determined by the total capacity of both condensers, while the actual tuning-in of the stations is made easier by the small bandspread condenser.

Even though this set uses an A.C. valve, that can have as many as 250 volts on its plate, we are not obliged to use as much as this, so that the 45-volt batteries that we have used while we were experimenting with battery valves will not be wasted. They can be still used with this set. Those who have invested in a power supply worked from the A.C. mains should not use more than 45 volts on this circuit, because to use higher voltages it needs alteration in some respects, as it has been arranged specially to suit a low plate and screen voltage.

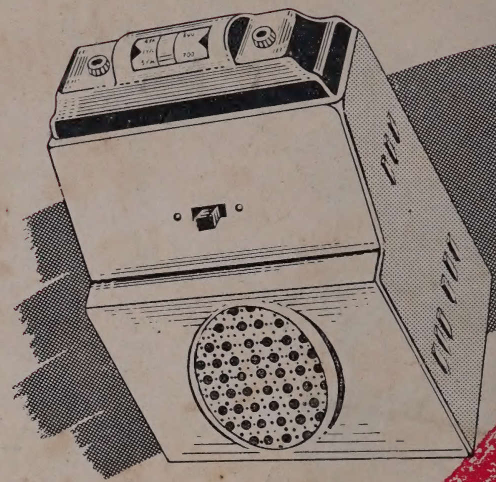
Full details of the actual construction of this set will be found in next month's instalment of the Beginners' Course.

(To be continued.)

AUTO RADIO

MODEL No. 39

6 volt or 12 volt



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